Natural Visions | Photography and ecological knowledge 1895-1939

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Abstract

This thesis is about ecology as visual science, and the role of photography in establishing and promoting ecology in Britain, as a new kind of knowledge and as a new scientific discipline, between around 1895 and 1939. In the historiography of early ecological science, the roles of photography and visual knowledge have remained largely unnoticed. Yet, from its beginnings in 19th century European phytogeography, to the first modern ecological vegetation surveys undertaken by British ecologists around 1900, ecology developed as a visual science. From the late 1890s, early ecologists insisted on a role for photography in particular, as a means of scientific investigation and representation.

The thesis explores the development of British ecology as a photographically visualised science, as ecologists promoted new surveys and photographic collections, establishing new institutions and new publications to promote their science. Photography became a ubiquitous field method, for recording and authenticating the complex objects and processes of ecology, and for promoting a broader ecological community of knowledge and practice.

Ecologists met on common ground with other natural scientists 'in the field', and this ground is illuminated by a consideration of wider visual, material and social practices. In particular, parallel practices of collecting and exchange — of natural objects and photographs — demonstrated a continuity between ecologists and other natural scientists, whilst also supporting the conceptual transformation instigated by ecological thought, and facilitating a new community of interest amongst ecological professionals. Through ethnographic and accounts of the field practices of ecology and related natural history studies, the thesis extends the study of visual and material culture in science and places photography and ecology within a broader economy of knowledge and material culture.

Drawing on archive sources from the British Ecological Society, Kew, Cambridge University, the Natural History Museum and elsewhere, as well as a wide range of primary published materials (especially early ecological journals), the thesis opens a new area in the study of photographic practice in the history of science. It demonstrates the value of archive-led photographic history, especially from less conventional photographic archival sources, as a tool for the mutual illumination of photographic history and the history of science.

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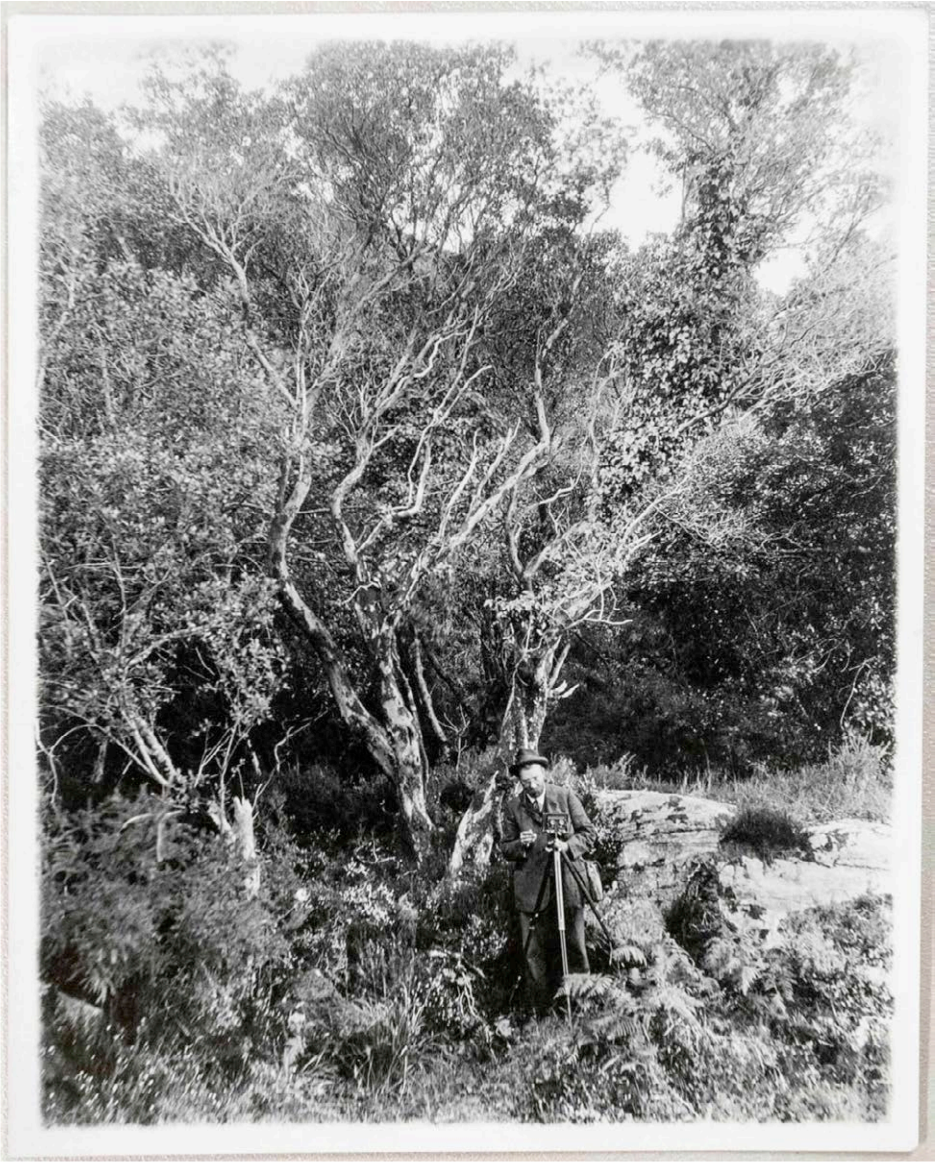

Frontispiece. Elizabeth Cowles. *Arbutus at Killarney, with Massart.* September 1911
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1. Introduction: Ecological history, visual science and photography

Those who have had the good fortune to accompany him in the field know the singular and almost instinctive faculty which Professor Flahault has of seizing, as it were at a glance, such essential features of the vegetation.[1]

'At a glance'

In the winter of 1896-1897, Robert Smith, a young Scottish botany student from Dundee accepted an opportunity to study at the Institut de Botanique, at the University of Montpellier, under the renowned botanical geographer Professor Charles Flahault. Since the early 1890s, Flahault had been surveying and mapping the vegetation of France and, to broaden his Scottish student's botanical perspective and alleviate the monotony of laboratory work, he invited Smith to accompany and assist him in his ongoing surveys. Together, they made long journeys across the south of France, from the Pyrenees to the Italian Riviera, observing and recording the region's flora and its varied vegetation.[2] Apart from the obvious attractions such journeys might hold for a botanist more used to the northern Scottish landscape, during these excursions Smith was especially struck by his Professor's "singular and almost instinctive faculty" for distinguishing and characterising different kinds of vegetation by eye. Whilst developing and exercising that eye, Flahault had walked many thousands of miles of French countryside and, assisted by his students, had mapped 120,000 square kilometres of its vegetation.[3] Flahault's project was the first attempt to recognise and map vegetation *per se*, not as the relative distribution of individual plant species, but as plant associations or communities that reflect the interactions between plants and their environment and amongst the plants themselves. This was the beginning of modern plant ecology as a science of complex biological relations above the level of the individual organism.

Smith's experience working with Flahault encapsulates a number of the central themes for this history of early scientific ecology and photography. First among them is the recognition of early plant ecology as a fundamentally visual science, requiring a trained and experienced 'eye' to recognise and describe a new kind of object, the plant association. The ecological study of vegetation required recognition of the consistent appearances of plant assemblages, whose composition and physiognomy gave expression to underlying

[1] Smith 1900: 387
[2] Thompson 1901
[3] Herbertson 1897.

environmental conditions.[4] This question of ecological vision — what it means to see as an ecologist — runs through all the chapters of this thesis. The development of an ecological eye required the development of new visual methods, for recognising and describing plant associations and related ecological concepts, for registering and communicating the visual knowledge in ecological fieldwork. The resulting techniques encompassed new forms of instrumentation for environmental measurement, and new methods for quantifying plants within different kinds of vegetation. Photographic technologies were especially well suited to these tasks and ecologists quickly recognised and embraced their potential, both as instruments of scientific observation and as rhetorical tools for describing the objects and findings of ecological science to others. Following Flahault, European ecologists developed new techniques in survey and mapping for these purposes, presenting cartography and photographic record as evidence for the objects and methods of a new botanical science. Accordingly, this thesis pays close attention to the uses of photography in early ecological methods, through which ecologists sought to regulate and authorise their new discipline, transforming visual intuition into rational science.

Whilst ecological knowledge was grounded in subjective field experience, it was also socially fashioned. Flahault's long survey-walks through the French countryside were undertaken as often as not in company with other botanists. Robert Smith in turn took Flahault's ideas and methods, discussed and applied them elsewhere, contributing to broader networks of knowledge formation and exchange. Photographic technologies were especially prominent in the communication strategies adopted by Smith and his immediate successors in British ecology for demonstrating their new insights to a wider scientific community. They found common ground with other natural scientists 'in the field', and in a shared culture of indoor discourse and photographic display, through which they formulated and promoted a common understanding of their developing subject. They took active roles in amateur societies and professional associations, founded new institutions to promote and develop their subject, and published new journals and books to further their new ecological ideas and methods.

Finally, the excursions of plant ecologists like Flahault and Smith reveal ecological knowledge as embodied knowledge, obtained in the field, through movement and

[4] This visual recognition remains a methodological prerequisite for modern vegetation science. As one ecologist has put it, "vegetation reveals at a glance the entire environmental complex." (Küchler and Zonneveld 1988: 523). For further examples of visual recognition in vegetation study See also ibid.: 304; Rodwell 1991: 17-18.

observation. Plant associations and environmental relationships could be understood only through direct contact with vegetation, by eye and on foot, and ecologists configured 'the field' both as a theoretical foundation for their subject and as a tangible space, constituted by the concrete places where ecological objects and processes could be witnessed directly. Through these embodied and social cultures of field science, ecologists retained their discursive and epistemological links with a broader community of field naturalists. The links are especially clear in common culture of photographic practice among ecologists and naturalists, both in the field and in the social spaces of natural history. As botanical naturalists themselves, ecologists had long been accustomed to exchanging natural specimens as tokens of knowledge. As ecologists, they began to exchange plant associations through photographs. They shared and talked over photographs in meetings, presented photographs in lectures and classrooms and in print publications. Together with maps and other visual artefacts, they put photographs to work as surrogates for the objects and encounters of field experience, as specimens for sharing ecological knowledge.

Visual science, visual ecology

This thesis is about photography then, about the visual practices of ecologists, and about the practice of ecology as visual science, as it emerged as a recognisable discipline at the start of the twentieth century. I mean by this that, in the chapters following this Introduction, I will consider *both* how the development of a visual culture among early ecologists assisted in promoting and defining ecology as a discipline with its own institutions and community of knowledge, *and* how the practical methods of early ecologists constituted their new science as a visual project and gave expression to an already embodied, visual encounter with the phenomenal world. In particular, I will show that this visual culture of ecological science was constituted pre-eminently through photographic practices; through an active rhetoric of photographic representation across the civic and disciplinary infrastructures of Edwardian science, and especially in scientific publication (see especially chapters 3 and 4); and through a shared culture of visual knowledge exchange founded on the already established cultures of collecting and exchange in natural history (chapter 6). In chapter 5, I demonstrate the special relationship of photography to the processes and experience of ecological fieldwork by examining the new visual – especially photographic – methods developed by early ecologists field investigations (chapter 5). These methods demonstrated the profoundly visual character of ecological field experience and photography's pre-eminent suitability both as an instrument of ecological observation and as a tool of scientific communication and rhetoric.

The work is founded on a combination of archival research and primary published sources. It is not a thesis about a particular photographic collection; still less is it about a selection of striking or notable 'ecological' pictures. The research draws on a large but diffuse body of visual and textual resources to interrogate the founding visual character of one of the most significant sciences of the 20th century. It does so without taking a presupposed theoretical stance, relying rather on the acquisition of theoretical tools in response to particular questions that present themselves in response to the historical source material. The argument proceeds not by evaluating primary sources in terms of existing theoretical frameworks but by analyzing and interpreting the data collected as part of the research process, in the notebooks and journals, correspondence and publications of ecologists, and especially in their photographs, drawn from a range of published texts on ecology and botany, and from a number of archival collections, very few of which are primarily photographic. Since the study has not been tied to a particular position, the key theoretical and methodological questions that emerge from the source material are to some degree inevitably idiosyncratic and it would be helpful to begin by bringing the most important of these to light.

The emphasis of my inquiry, laid on *practice*, identifies a central insight of the broadly constructivist position which has come to dominate the history of science over the last thirty years.[5] An acknowledgement of the importance of social factors in the making and circulation of scientific knowledge, of science's contingency upon its own material and cultural contexts, now seems so widely accepted that the position hardly seems worth stating. However, like all influential methodological positions, constructivism has diversified and proliferated under numerous guises or secondary methodologies since it first came to prominence. As Robert Kohler put it, constructivist methods have become indispensable but they do not constitute a clear, single programme. Constructivism, he says, is "a grab bag of useful tools from which historians will select those that are useful for their own purposes."[6] Whilst the original work of the constructivist project, to uncouple historical and sociological studies of science from normative epistemology and progressionist narratives, seems complete, it is worth recognising that, as a broad perspective, constructivism still underpins many of the tools

[5] Secord 2004: 658.

[6] Kohler 1999: 331. The most useful summary history of the rise of constructivism in the history of science is provided by Golinski 2005. Kohler made his remarks in a review of Golinski's book.

selected from the grab bag of methods for this study. First among them is an emphasis on practice, and an associated leaning towards ethnographic methods. It was the anthropologist Clifford Geertz who said that "if you want to understand what a science is, you should look in the first instance not at its theories or its findings, and certainly not at what its apologists say about it; you should look at what the practitioners of it do."[7] With the caveat that what practitioners say — speaking sometimes as apologists, sometimes as 'doers' — is also a relevant form of doing, this is my methodological starting point. This is a study from 'inside ecology',[8] taking as its primary analytical material the words and deeds of ecologists as scientific and photographic practitioners.

The resources for an ethnographic account of ecological practice are material, social, discursive, technical and subjective. In particular, the visual perspective adopted here places a strong accent on the objects of ecology, and on the social and technical practices of ecologists, rather than attempting a genealogy of ecological ideas. The conceptual content of ecology is inseparable from its objects and practices and remains embedded in such an approach, but it does not drive the narrative of ecological development, rather it is allowed to emerge from discourse and practice. The merit of this approach is that it allows the historian of ecology to attend to social and material practices that might otherwise appear incidental or ancillary to the 'real' content of ecological science but which, nevertheless, have real explanatory power for ecological theory and method. Objects and theoretical constructs which practitioners treat as self-evident are called into question and specific practices are revealed as drivers for disciplinary definition and development.

In taking a visual and photographic perspective, the aim of this thesis is to cast new historical light on the distinctive epistemological content of early ecology,[9] and on the ways in

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[7] Geertz 1973: 5. Much of the literature on practice theory is referable to Pierre Bourdieu's foundational text, 1977 and in particular his concept of *habitus*. Practice-oriented studies in science and technology studies appeal to a wider range of origins than this, however. For a broad understanding of the foundational thinking in 'practice theory' in science studies two important collections of essays include contributions from many of the most prominent figures of this so-called 'practical turn' (Pickering 1992 and Schatzki *et al* 2001). For a discussion on the 'theory' of practice, see Stern 2003 Lynch 1993 provides an engrossing introduction to the philosophical foundations for ethnomethodology in the social study of scientific practice.

[8] I adapt the phrase from Edwards (2012a: xi), whose study of the British photographic survey movement provides a highly instructive model for any ethnographically-oriented history of practice.

[9] For a useful account of historical epistemology and its philosophical foundations, see Nasim 2013a. I maintain here, and throughout this thesis, a critical separation between philosophical epistemology and historical epistemology. This is a work in historical epistemology, which is concerned not with the philosophical validity of ideas and knowledge practices but with their distinctive formations and historical contingencies.

which the first ecologists separated their science from established forms of knowledge inherited from 19th century life sciences. In recent decades, the hegemony of the written text, as the primary source of history has been widely challenged and visual practices, in other sciences at least, have come under increasing attention from historians, philosophers and sociologists of science. Historians of science have previously relied largely on written sources, whilst scientists themselves have often paid little conscious attention to their own visual practice. Widespread but under-theorised forms of practice, such as photography, escape critical attention under such conditions, regarded by practitioners and historians alike as ancillary to the real content of science and its history. Attention to the visual practices of science arose in the context of a broader, so-called, 'visual turn' in cultural studies, social sciences and humanities in the 1980s and 1990s. Contributors to a 'visual turn' in science studies have included art historians, anthropologists, philosophers and sociologists, though only rarely scientific practitioners themselves.[10] An important exception is Martin Rudwick, whose early re-focussing of attention from text to image explored the visual language of 18th and 19th century geology, before the field of visual studies ever emerged.[11] The work of these early pioneering visual studies is cited as a continuing inspiration by recent scholars of visual culture, including the visual cultures of science.[12]

At the same time, building on ethnographic accounts of scientific practice, the visual practices, ontologies and epistemological work of scientific representation came under sustained scrutiny in sociological and philosophical studies of scientific image production.[13] Scholars of scientific images have since looked at the fullest imaginable range of illustrations, graphs, equations, maps, photographs, films and digital images, in a wide range of scientific contexts.[14] Taken within the broader compass of visual representation in science, many of

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[10] For a useful historiographic review of visual culture studies, see Dikovitskaya (2005; 2012). Sandywell (2012) has attempted a comprehensive bibliography of the field of visual studies in all its disciplinary guises. The 'visual turn' has developed a considerable momentum, with associated literatures in fields as diverse as geography, cinema, design, buildings research, sociological inquiry, feminist theory and sports history, as well as the history of science.

[11] Rudwick 1976.

[12] See, for example Hentschel 2014: 62-63.

[13] Now canonical examples of ethnographic study in laboratory science include those of Latour and Woolgar 1979 and Knorr-Cetina 1981.

[14] For case studies of scientific imaging practices, see Lynch and Woolgar (1990) and Coopmans et al (2014). Particularly influential longer studies have included Peter Galison's (1997) examination of the instrumental production of images in physics, whilst Lorraine Daston and Peter Galison (2007) have traced the history of visualisation in scientific and medical atlases to demarcate the changing epistemic configurations of objectivity. Pauwels (2006), Burri and Dumit (2008) and Gross and Louson (2012) have all sought to provide overviews of the multiple perspectives involved in studies of

these inquiries have included photography and its related technologies, but there have been surprisingly few studies that focus specifically on the related histories of photography and science. Of these, several began as catalogues for historically inspired exhibitions of notable scientific photographs, some of which also incorporate useful critical essays for contextualising the exhibition images.[15] Jennifer Tucker has written an important history of the parallel histories of photography and Victorian science, concentrating in particular on their mutual construction of scientific evidence and authority. Kelley Wilder, meanwhile, has published a thematic study, also considering the evidential status of photography, articulated in scientific concepts of observation and experiment, archiving and the aesthetics of scientific images.[16]

This rich tradition in visual study notwithstanding, ecology has thus far escaped the 'visual turn'. Visual modes of investigation and communication were essential to the establishment and development of early ecological practice, yet visual accounts are absent from histories of 19th and 20th century biology and ecology. This thesis is, consequently, is the first attempt to describe the visual practices of ecology, and to investigate their role in the formation of a new conception of the natural world and of a new scientific discipline for the 20th century. One important reason for the neglect of visual ecology, and especially of ecological photography, may be its tendency to produce unremarkable images. The great mass of scholarship in visual science studies, including the history of photography in science, has been written largely under the assumption that the business of scientific representation is to render the invisible visible. This kind of visualisation has indeed been a central function in almost every field of scientific representation, as scientists have sought to describe phenomena inaccessible to human vision, or to communicate the complex abstractions of scientific ideas through the simplifying filter of rational visual arguments, whether in photographs, etchings, diagrams, graphs or tabulated data. The canon of 'scientific images' gathered into exhibitions and catalogues of scientific photography is devoted almost entirely to this assumption, that photography's contribution to science has always been its capacity to enhance vision, to draw the invisible into the visual realm. Scientific photography has brought into common view the impossibly distant objects of astronomy and the inconceivably small discoveries of

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scientific visualisation. The most comprehensive current overview of 'visual cultures' in science, and of their historiography, is to be found in Hentschel (2014).

15 Darius 1984; Iles and Roberts 1997; Thomas 1997; Keller 2008. Ann Thomas (1997: 10) provides a short list of other important exhibitions of scientific photography in North America and Europe between 1967 and 1997.

16 Tucker 2005; Wilder 2009.

microscopy. It has frozen moments and motion, registering an abundance of detail imperceptible in the flow of common life. Through x-ray and other scanning technologies, it has shown us the picture inside solid objects and, even when photography can show us only surface, it has been assumed to reveal underlying or essential qualities not accessible to ordinary sight.[17] Whilst they rely less on canonical images and give more attention to the ordinary social practices of science and photography, critical histories like those of Jennifer Tucker and Kelley Wilder nevertheless devote considerable space to discussions of photography as a technology of extended vision. Tucker's study ranges widely in social and historical scope to show how scientific authority and conviction were constructed around images of the unseen objects of astronomy, bacteriology, meteorology and even spiritualism, on the basis of "the power of new scientific instruments such as the camera, the microscope, and the telescope…to enhance perception and constitute new perceptual objects."[18] These scientific uses of photography, as Wilder points out, amounted to "entirely new methods of observing."[19] This deliberate foregrounding of photography's prosthetic potential for extended vision has the effect of construing 'scientific photography' as a genre of extraordinary views. This essentially positivist conception of science, as a project for extending human perception and knowledge beyond the bounds of common sense and the commonplace, is hardly consistent with the practice of a great deal of ordinary scientific observation, much of which is not reliant upon technologies of extraordinary visualisation.

On the contrary, very often scientific photography describes just what is already open to view. Both Tucker and Wilder consider other kinds of scientific photographs too, those for which reliable record and accurate description were more highly valued than visual or epistemological novelty. Thus, Tucker discusses photographs of ferns by Celia Glaisher from the 1850s, and photographic contributions to scientific conversaziones and exhibitions in the 1870s, encompassing botanical, ethnographic and topographic subjects as well as solar spectra and comets.[20] Whilst Francis Galton's composite images of racial and social types sought hidden truths through photography, Sir Benjamin Stone's 'National Photographic Record' and Albert Kahn's 'Archives de la Planete' were attempts to record the ordinary appearances of life for collective memory.[21] Wilder argues that the urge to create such

[17] Examples can be found in any of the exhibition catalogues listed above.
[18] Tucker 2005: 7.
[19] Wilder 2009: 43.
[20] Tucker 2005: 30-31, 195-199.
[21] Wilder 2009: 44-47, 79.

comprehensive photographic archives, from at least the 1870s, was an impulse "to gather up an infinite number of details",[22] literally to describe everything, including even the most ordinary natural objects and artefacts. However, the urge to collect facts is not the same as the impulse to describe. Archival collections, Elizabeth Edwards has observed, were "constituted through tensions between the structures of generality and the demands of the particular."[23]

Fig. 1.1. Sydney Mangham. *Staffhurst Wood, Surrey, pedunculate oakwood on Weald Clay.* c.1910. BES Tansley Photographic Collection. MAN/1.Critical consideration of photographic collections and archives is important for understanding generalised cultural dispositions towards knowledge, but analysis at the level of the archive risks obscuring the ordinary descriptive work of individual photographs or smaller groupings with a common origin, which record particular acts of observation, historically situated and uniquely contextual, not contributions to a general archive but living descriptions of the particular. When early ecologists set out to recognise and describe vegetation, they aimed at this level of particular observation,

[22] Ibid.: 80.
[23] Edwards 2012a: 110.

employing photography to produce what they thought were clear, straightforward visual accounts of specific plant associations and the places where they could be found (Fig. 1.1). As we will see in chapter 2, and as Robert Smith and Charles Flahault's excursions testify, this visual recognition of plant associations lay at the centre of ecology's new scientific enterprise as it emerged out of 19th century phytogeography. Ecologists learned to *see* vegetation differently, as complex associations of plants, and this new way of seeing was reflected in a descriptive mode which paid considerable attention to visual experience and to visual methods for presenting that experience to others.

Exchange and flow

As Jennifer Tucker has demonstrated, the evidential value of scientific photographs was not achieved solely through appeals to optical realism, or to mechanical objectivity, and still less to their capacity for detailed or complex description. Scientists and others debated endlessly about what exactly was evident in particular photographs and, as Tucker says, such debates require us to attend to other "processes through which people mobilised and used photographic evidence."[24] Settling the epistemological confusion of ecological photography required persuasion. The evidence of photographs had to be demonstrated and sceptics won over. Like other scientists, ecologists tried to persuade their botanical colleagues by a mixed strategy of publication and display, in scientific meetings and lectures, and by direct involvement at every level in scientific societies, from the British Association to their local natural history societies. However, since ecological photographs purported to describe objects in the natural world, not in laboratory specimens, or at the end of a microscope, this especially meant demonstrating plant associations in the field, as well as in the lecture hall. Ecologists already shared in the established culture of natural history clubs and field excursions and, whether in meetings or out and about, their efforts to persuade were characterised by a marked sociability in which naturalists, botanists and ecologists shared ideas and experience, specimens and views, and discussed the meaning of what they saw together.

Chapter 3 of this thesis, which traces these social articulations of ecological knowledge, highlights the International Phytogeographical Excursion (IPE) of 1911, which was a notably ambitious attempt at precisely this kind of sociable demonstration of the knowledge obtained by taking an ecological 'view' of vegetation. Elizabeth Cowles' photograph of Massart beneath

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[24] Tucker 2005: 4.

a strawberry tree in Killarney was one of many she took during the IPE (Frontispiece) and she and Massart were not the only photographers on the excursion, even if they were the most prolific. In joint excursions like the IPE, ecologists refined their collective understanding of the objects of ecology. Consequently, this thesis also stresses the sociability of ecological practice and knowledge formation. Through events like the IPE, ecologists began to build a community of practice that was truly international and they recorded that community with photography (Fig. 1.2). They learned to see one another's plant associations and, in subsequent photographic exchanges, they saw themselves observing and discussing what they had seen and learned together, reinforcing both the social and disciplinary connections of their scientific practice.[25]

Fig. 1.2. Elizabeth Cowles. *Blakeney, International Phytogeographic Excursion, 1911.* BES Tansley Photographic Collection. COW/8.

A great deal of the work of the 'visual turn' in the history of science, as Gregg Mitman and Kelley Wilder have pointed out, has pursued visual representation in this way, as a site for investigating the predominantly social practices at work in the production of scientific knowledge.[26] This has been a rich and fruitful line of inquiry and has opened a great many

[25] For a similar consideration of the culture of field excursion amongst amateur photographers, see Edwards 2013.

[26] Mitman and Wilder 2016 (In press).

questions about the epistemological work of visual artefacts, from photographs to mathematical equations, as well as the overlapping cultures of scientific practice and their social articulation. In particular, this approach has underlined the importance of understanding the effects of mobilisation on photographic evidence in science. The mobility of photographs and other visual objects (such as maps and sketches) has been understood as a means of fixing evidence, transferring and stabilising meanings in the transfer of knowledge across boundaries, both geographical and social. Scientists see and engender confidence in scientific objects, Bruno Latour insists, "once they stop looking at nature and look exclusively and obsessively at prints and flat inscriptions,"[27] and Jennifer Tucker repeatedly exhorts scholars to follow the ways in which photographs were 'mobilised' in this way as evidence for scientific knowledge claims.[28] The fixation of evidence is a negotiated process, however, and others have emphasised the 'infinite recodability' of photographs, their susceptibility to appropriation and re-purposing, presenting new meanings for new contexts of use.[29] In this thesis, we see this effect repeatedly in the transfer of botanical images, both drawings and photographs — for example, from the contexts of exploration and travel to those of ecological vegetation study (chapter 2), and in the use of taxonomically driven 'plant portraits' in photographic atlases of vegetation communities (Chapter 4). The resulting epistemological confusion almost certainly also hampered the development of appropriate photographic collections for both academic botany and vegetation ecology (Chapter 3). Similar recoding effects can be seen at work also in early ecological mapping practices (Chapter 5). Images change as they circulate. They are exchanged, moved not only from hand to hand but from place to place; they are reproduced, reiterated and transformed in new contexts. As they circulate they are debated and challenged and sometimes agreed over. Whether the social mobilisation of images fixes or transforms meaning, however, it is in the material 'exchange and flow' of photographs, as Elizabeth Edwards has called it, that knowledge is (more or less successfully) worked out.[30]

Photographs operate within a broad complex of cultural and material conditions, which James Hevia, drawing on Bruno Latour's network theory, has called the 'photography complex'.[31] Hevia's concept is helpful for this thesis for two reasons. Firstly, it extends inquiry

[27] Latour 1990: 39.
[28] Tucker 2005: 4, 234.
[29] Edwards 2001: 5 et pass.; Edwards and Hart 2004: 5
[30] Edwards 2000: nn.45
[31] Hevia 2009

beyond the photographic image itself, to suggest photographic production as the outcome of complex interactions between numerous human and nonhuman actants, from photographers to photographic emulsions, from cameras to lecture halls, landscapes and laboratories, revealing the broader cultural and disciplinary underpinning of scientific photography. Photographs function, more often than not, within other networks of agency,[32] turned to representational, aesthetic or informational purposes in any number of contexts. Only a few of these take the 'photographic' as their primary raison d'être but photography may operate, nevertheless, decisively to shift the cultural and epistemological landscape of a scientific discipline. Secondly, in considering the photography complex as a web of overlapping and interpenetrating networks, which operate in the processes of cultural production, inquiry is led to consider questions of the mobilisation and communication of visual knowledge. This social agency of photographs, in their production, circulation and consumption, is also captured in Deborah Poole's concept of the 'visual economy', which places images within "a comprehensive organization of people, ideas, and objects." Importantly, Poole's understanding of the working 'visual economy' particularly emphasises the circulation of images and the 'cultural and discursive' systems within which they are negotiated and acquire meaning.[33]

In recognition of this negotiated and contingent status of photographs, this thesis largely avoids theoretical discussions about photography's ontology, in favour of an emphasis on the disciplinary practices of photography, both as a methodological tool and as a medium of knowledge exchange. As far as early ecologists were concerned, photographs provided transparent description and, therefore, direct evidence for plant associations or whatever else might be before the camera. The photograph provided irrefutable evidence of the specific locations where vegetation of a particular character could be seen, and of its witnessing by the ecological photographer. Visual evidence of this kind was simple, compelling and apparently unambiguous. For some botanists, those who were unsure of the plant association itself,

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[32] The attribution of social agency to material objects is to regard them as active and dynamic participants in social (inter)actions, involving both people and things. It is not necessary to accept fully the notion of agency in inanimate objects to see their dynamic and powerful participation in social relations and interactions between people and their material world. The notion of material agency has two entry points into the study of visual culture. The first has its origins in Alfred Gell's anthropological treatment of *Art and Agency* (Gell 1998) and in W.J.T. Mitchell's, *What Do Pictures Want?* (Mitchell 2005). The second is from the social studies of science, in the actor-network theory associated especially with Bruno Latour (Latour 1987, Latour 1993, Latour 2005). For a useful summary discussion of the various theoretical positions on agency, including actor-network theory, see Dant 2005: Ch.4, 60-83.

[33] Poole 1997: 8-10.

photographic description alone could offer little help for understanding plant ecology. The epistemic uncertainty experienced by many botanists faced with the ecological view of vegetation inevitably also encompassed its photographic representation. For many, there was no guarantee they would 'see' the plant community before them, even had they been present beside the ecologist-photographer.[34] In such contexts, early ecologists set photography to work as a tool for scientific observation, but also as a rhetorical space for negotiating objects and evidence. They did so within the established institutional contexts of professional and amateur science, and within new institutions established specifically to promote ecological science and practice. Within this nexus of practice, photographs were made, reproduced, exchanged and circulated, and it is in this currency that sociologists and historians of science, and anthropologists in particular, have located the social and epistemological agency of photography.[35]

This social-material approach to the visual practices of shared viewing and exchange, and of photographic collecting and display, has been especially important to my understanding of the detailed social operations and institutional frameworks developed by ecologists in the first decades of the 20th century. In thinking about ecological photographs, therefore, I have sought to reconstruct the cultural experiences of ecologists as they attended meetings and conferences, sharing photographs as sensory objects, haptic as well as visual tools for thinking and talking about natural objects. Contrary to Latour, as we will see in chapter 3, ecologists were more likely to start seeing things when they looked at 'nature' together, whether in the field or in photographs. Ecologists viewed and discussed photographs of vegetation as real examples, no more and no less confusing as two-dimensional images than the three-dimensional objects of the field. They discussed theories of vegetation over such photographs too, but they did so in just the way they discussed vegetation in the field, discerning plant associations, their structure, detailed species-composition and habitat characteristics. Ecological objects and their characteristics were discussed and contested, in the field and in photographs, sometimes in both at the same time. In this context, the visual experience of nature and its photographic proxies were sites of negotiation, not fixed meanings. This perspective on certain kinds of inscriptive practice has been taken by others, for example

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[34] The ontology of photographic representation is of little help here. Photography, John Tagg has claimed, has no identity of it own. "Its nature as a practice depends on the institutions and agents which define it and set it to work" (Tagg 1988: 63). In other words, photography borrows from its contexts of use and, consequently, an ecological photograph has no ontology *qua* photograph; it is an ecological photograph through ecological practice.

[35] Poole 1997; Pinney and Peterson 2003; Morton and Edwards 2009.

Omar Nasim, who distinguishes between the 'immutability' of published scientific images and more tentative 'working images', used as tools of observation and subject to exploration and modification, only later to be transcribed into a fixed apparatus of collective empiricism.[36]

Fig. 1.3. Arthur Tansley. *Banks Wood, West Malvern.* Undated. BES Tansley Photographic Collection. TAN/10/7.

The manifestations of photographic circulation and the material life of photographs in 19th and early 20th century science were numerous, from society meetings and soirées to private correspondence and field practice. Two distinct modes of circulation and material efficacy were particularly significant for scientific photographs, however, and both provide important resources for following ecological photographs at the start of the 20th century. The first was the photographic collection or archive, which was variously realised or aspired to in numerous sciences from the 1870s onwards, from astronomy to geology, anthropology to meteorology.[37] Collections of this kind were perceived by scientists in numerous fields as essential supports for the creation of enduring repositories of knowledge for current and

[36] Nasim 2013b: 10. On collective empiricism, see Daston and Galison 2007: 19 *et seq.*
[37] Tucker 2005: 62.

future research.[38] Early ecologists shared this widespread conviction in the value of a photographic archive for the benefit of current and future science and chapter 3 also explores the development and fate of ecological photographs as they were collected in institutional contexts (Fig. 1.3,) and by private individuals. Such collections made apparent not only an ecological conviction in the value of the photographic record and its archive, but also a deep epistemological confusion between floristic botany and ecological vegetation science.

The second and perhaps more important mode of (re)production and circulation for ecological photographs was print publication (Fig. 1.4).[39] From the 1880s and 1890s, the emergence of an illustrated press able to exploit new technologies of photomechanical reproduction (principally the halftone print) had begun to offer new possibilities for visual communication in print. As we will see in chapter 4, had anyone been looking, the turn of the 19th–20th centuries would have revealed a startling increase in the diversity and frequency of photographic practice in botany, coinciding with the emergence of 'self-conscious ecology'.

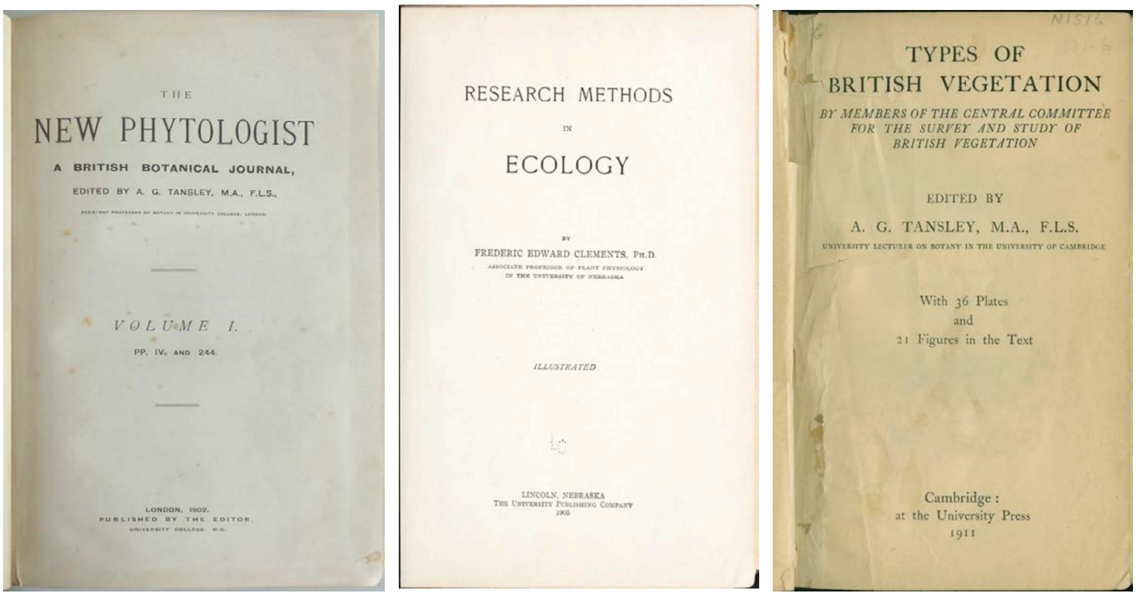

Fig. 1.4. *New Phytologist*, Volume 1, 1902; F.E. Clements 1905, *Research Methods in Ecology*; A.G. Tansley (ed.) 1911, *Types of British Vegetation.*

This new visual culture in print set ecology apart from its 19th century progenitors and from taxonomic botany and formed the rhetorical foundation for promoting ecology as a

[38] For a discussion of scientific photographic collections, see Wilder 2009: Ch.3, 79-101.

[39] In the last decade or so, journals and other serial publications have become a particular focus of attention for investigating the circulation and popularisation of Victorian science. See, for example, Cantor and Shuttleworth 2004; Lightman 2007; Hopwood *et al* 2010. In a study of Victorian popular science journals, Geoff Belknap (2016) argues that illustrated periodicals, in particular, constituted a significant site of scientific controversy in the late Victorian period, with photography to the fore.

discipline and a set of practices for investigating the natural world. Like the photographs in collections, the ecological image in print presented evidence and illustration for the new objects of ecology. Here, however, photographic evidence could be supported by text, maps, botanical information and other data. The resulting visual print culture not only contributed to an epistemological rhetoric in support of plant communities, it also provided a discursive and institutional centre around which the imagined community of ecology could cohere and sustain itself.[40]

The narrative presented in this thesis (see especially chapters 3 and 4), of ecologists' participation in the British Association for the Advancement of Science, their harnessing of the power of print publication, and their thriving social engagement through amateur societies, professional associations and international excursions, answers in part to James Secord's call "to think much more explicitly about the problem of the movement of local knowledge."[41] It was in the communication between ecologists and between ecologists and other kinds of scientists — especially other field scientists — that ecological questions were raised and resolved. In particular, ecologists published intensively to 'get their ideas out there' and this thesis examines particular texts to see how this was achieved, if not always successfully, through the uses of photography in a range of different geographical and social contexts.

Visual methods, visual tools

When scholars today attest to the enormous literature on the visual cultures of science, they generally mean studies of visual representation; how the objects of scientific research have been "shaped into graphic and pictorial data"[42] — that is, into disembodied images. More particularly, they usually mean scientific practices for *visualising* objects and phenomena that are ordinarily inaccessible to human vision.[43] Or, very often, they mean *making visible* processes or phenomena that are not visual at all, such as statistical data or certain kinds of instrumental observation.[44] Such images are literally *ideal pictures,* without reference to the objects of common perception, visible only through optical instruments or graphic artefacts.

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[40] For Benedict Anderson, who coined the term, the formation of a print culture is seen as central to the development of an 'imagined community' (Anderson 2006).
[41] Secord 2004: 660.
[42] Lynch 2006: 29
[43] Lynch and Woolgar 2014: vi
[44] Visualisations of non-visual data include diagrams, graphs, table and equations, but also imaging techniques for non-visual phenomena, such as radiation or DNA 'fingerprinting'.

Most photographs are not representations in this sense at all. Always selective, always ideological, and frequently qualified by aesthetic values or other subjective concerns, most photographs nevertheless re-present the contents of ordinary vision. Yet Jennifer Tucker's study of Victorian science and photography is, as she says, a "history of the experience of looking at scientific photographs"[45] — not a history of vision but a history of image artefacts, albeit material and socially mobilised. Daston and Galison's study of objectivity through scientific atlas images, likewise, focuses on the making of scientific images as negotiated acts of visualised representation,[46] whilst Klaus Hentschel's recent study of the v*isual cultures* of science and technology is exclusively concerned with visual representations in science.[47]

The study of visual culture as visualisation, or purely through its artefacts — whether as disembodied images or objects with agency — is problematic. It risks segregating visual representation from the broader realm of visual experience, and from the fundamental idea of what it means to know visually.[48] When the first ecologists went out into the field, they went equipped with cameras to record the ordinary contents of vision; what they saw with their own eyes. They recognised the persuasive power of photography for its offer of direct visual encounter, seemingly without the structured mediation of other kinds of representation.[49] In this thesis, my account of ecology as visual knowledge suggests that the study of visual culture needs precisely to encompass vision as more than its representation, more than the encoding of experience into pictures. Ecological knowledge, and its associated visual skills, were not won by reading journals and manuals of ecological methods. Charles Flahault did not develop his facility to grasp the character of vegetation 'at a glance' merely by looking at photographs, or any other kind of 'flat inscription'.[50] The community of visual practice that developed amongst early ecologists was bound not simply through the indoor practices of display but by shared practices of the field. As field scientists, they understood printed pictures precisely by reference to field experience, to which they looked for ultimate

[45] Tucker 2005: 5.

[46] Daston and Galison 2007.

[47] The history of visual culture, for Hentschel, is a history of its representations. Culture in general, following Clifford Geertz's semiotic anthropology (Geertz 1973), has been presented as entirely representational. In such a case, thick ethnographic description consists in detailing the many and complex forms of symbolic life, whilst anthropological insight is a matter of symbolic interpretation.

[48] Hentschel has strong views on what counts as suitable matter for 'visual studies'. Amongst what he calls "wrong turns of 'the visual turn'", he particularly objects to visual culture construed as "the social construction of visual experience" Hentschel 2014: 76.

[49] This is what Roland Barthes meant when he called the photographic image "a message without a code" (Barthes 1977: 17).

[50] Latour 1990: *loc. cit.*

authentication for their knowledge of organisms and their environment. Print publications, pictures and indoor talk were all critical to the exchange and regulation of ecological practice, both in the field and in the laboratory, and photographs were a constant point of reference for these purposes. Any account of ecology as visual knowledge must address the role of photography or other visual technologies as part of an embodied experience of scientific field practice, not solely in relation to representation. Photography in ecology was not solely a matter of making pictures, it was also an instrument of direct observation and sensory experience, of embodied knowledge.

Unpacking this instrument requires particular tools of inquiry. Firstly it requires the emphasis on practice that I have already declared, but applied more specifically to the visual practices and methods of ecology, not solely to its representations. Secondly, it requires attention to the places where those practices were performed which, for ecology, means that we must examine 'the field' as a distinctive place of scientific study. For the former, it will be necessary still to consider questions of representation, especially of the visual strategies adopted by ecologists for understanding and communicating specialist knowledge. But I am concerned also with the visual foundations for knowledge formation at the point or 'sharp end' of scientific practice; that is, how visual knowledge is engaged or generated through interaction with the objects of scientific study. To this end, this thesis investigates not only the social and discursive uses of photographs in ecology but also the uses of photography and other visual techniques in ecological field practice.

Whether they assembled for a joint field excursion, or embarked on fieldwork alone, ecologists went equipped with common technologies of record and memory, including maps and notebooks, plant guides and vasculums (all standard tools for botanical field study) to collect detailed observations on plant life (see chapter 3). But their most important instruments for ecological study were undoubtedly maps and the camera. Maps were used not just for wayfinding but for detailed mapping of vegetation by eye. Cameras provided visual records and detailed description for plant species and communities, as well as records of disciplinary practice and of the common experience of collaborative endeavour. In addition, ecologists developed complex arrays of technical instrumentation for environmental measurement (chapter 5), including a range of more detailed techniques for recording and mapping vegetation. The most important of these, the quadrat, together with its related photographic record, was the simplest of scientific instruments and a technique of lasting influence in ecology. It was also the most visual of aids to ecological research (Fig. 1.5).

Fig. 1.5. Arthur Tansley. *Crockham Hill Common, Developing Ericetum cinereae.* c.1907. BES Tansley Photographic Collection. TAN/3/6.

Visual places, visual bodies

In attending to material practice in this way, as I have already suggested, inquiry quickly comes up against the methodological twin of practice, that is *place*. The place where science gets done profoundly influences the kind of science that it is possible to do, and the kind of knowledge produced.[51] Scholarly differentiation of the places of scientific practice over the past few decades has recognised a vast range of spaces for doing science, including laboratories, gardens, museums, observatories, hospitals, lecture theatres, coffee houses and pubs; even cathedrals, ships and tents have been encompassed in the resulting geographies of science.[52] This more general spatial turn has also stimulated consideration of the field as a

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[51] As Thomas Gieryn put it in 2002, "All scientific knowledge-claims have a provenance: they originate at some place, and come from there."(Gieryn 2002: 113). Gieryn's remark reflected a growing concern with the geographical specificity of scientific practice and its resulting knowledge claims, which began almost thirty years ago when social scientists and scientific historians began to undertake detailed studies of the places and practices of modern laboratory science, and the history of experimental sciences (Latour 1987; Latour and Woolgar 1979; Shapin 1988). This acknowledgement of locality, according to Peter Galison (2008: 119), is perhaps "the single most important change in the last thirty years" in the history and philosophy of science.

[52] Livingstone 2003: 81-85. A valuable summary of the history of place in the history of science is provided by Henke and Gieryn 2008.

space for doing science, in some cases including field natural history.[53] The attention paid to field biology has been sporadic, however, and the field practices of ecologists in particular have received surprisingly little attention.[54] General histories of ecology frequently include at least some account of field methods but these are largely uncritical with respect to the field as a distinct place of scientific activity. Kaat Schulte Fischedick has provided the only study I know that considers in detail the field practices of ecologists, whilst Robert Kohler's *Landscapes and Labscapes* is the most considered discussion of the mutual definition of these spaces in biological science, and the traffic between them, across what he calls the 'lab-field border'.[55]

Kohler's study extends a theme for theorising the field, proposed by Dorinda Outram in 1995, which contrasts the 19th century indoor spaces of the 'sedentary naturalist' with those of the expeditionary field naturalist.[56] In the resulting, deeply class-inflected division of labour, gentlemen and academic botanists — systematists, botanical geographers and anatomists alike — remained at home, receiving specimens from globe-trotting, 'artisan' field collectors.[57]

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[53] Kuklick and Kohler 1996; Dewsbury and Naylor 2002; Naylor 2005; Finnegan 2008; Withers 2009. Robert Kohler has also helpfully reviewed again some thematic trends in the historiography of field science. Kohler 2011, Kohler 2012.

[54] There have been numerous micro-studies over this period, however, as well as a few more extensive treatments of the outdoor practices of natural history and its related sciences. David Allen, whose *The Naturalist in Britain* remains the founding study of field naturalists in Britain (Allen 1976), is centrally concerned with patterns of social behaviour and the institutional organisation of natural history, but he also engages widely with the scientific practices of naturalists, both in and out of doors. He has also charted the history of British floristic botany (Allen 1986). Further social histories have since been written for more specific natural history interests, including botany, birds and butterflies (Barrow 1998; Moss 2004; Salmon 2000), and for particular naturalists. In his study of the career of Joseph Dalton Hooker, Jim Endersby (2008) devotes two short chapters to the travelling and collecting practices of 19th century expeditionary botany. Janet Brown has dedicated a whole volume of her two-volume biography to Charles Darwin's voyaging, with hints of Darwin's field practices scattered throughout (Browne 1995, Browne 2002). For examples of micro-studies of field practice, both historical and contemporary, see Secord 1994; Jardine *et al* 1995; Camerini 1996; Law and Lynch 1988; Lorimer 2008; Cameron and Matless 2003. For meditations on the role of place in modern ecology, see Billick and Price 2010. Some anthropologists have also theorised aspects of field practice and the relationship of their study to place eg. Coleman and Collins 2006. Kuklick 2011 has also pondered some common ground between anthropologists and naturalists in the field.

Perhaps unsurprisingly, geographers have been among the most active in pursuing the implications of localised scientific practice, and have provided some of the most considered accounts of the field practices of natural history, to place alongside the relatively few studies undertaken by historians of science. Naylor 2002, Naylor 2003, Naylor 2010; Withers and Finnegan 2003; Finnegan 2005; 2009; Alberti 2001; Kohler 2006. See Livingstone 2003 and Powell 2007 for reviews of the growth of interest in this area amongst geographers.

[55] Tobey 1981; Sheail 1987; Schulte-Fischedick 1995; Kohler 2002a.

[56] Outram 1995.

[57] This division of labour was particularly marked amongst naturalists, and especially botanists, but cut across a number of other natural and human sciences in the 19th century. Henrika Kuklick, for

Objects thus returned from the field were authenticated, arranged, catalogued and studied by scientists working indoors, in what Bruno Latour has called 'centers of calculation'.[58] Here, the savant was one who collated, ordered, analysed and transformed the field collections and observations of others, synthesizing knowledge according to predetermined questions of taxonomy, morphology and distribution. This social differentiation of scientific activity resulted in a separation at the heart of biological knowledge, between the generalised, detached and objectivised spaces of the metropole, and the particularised, engaged and subjective spaces of the field periphery. Towards the end of the 19th century, the indoor spaces of the sedentary naturalist were supplemented, and then supplanted, by the new biological space of the laboratory, which was everywhere dominant by 1900. According to Robert Kohler, this changed the logic of place for biological science, placing a new emphasis on knowledge that was supposed independent of the places where it arose. In this bifurcated model, power and knowledge are asymmetrically distributed. The 'center of calculation' is assumed to be the generative centre of knowledge-formation, whilst the field periphery is portrayed as an unruly space, subject to regulation from the networked, authorising centre. It is one purpose of this thesis to question this asymmetry and to consider the role of field practice itself as a generative epistemological space, a place of knowledge.

The placeless knowledge of the laboratory itself came under pressure from some field biologists — ecologists with laboratory training — who began to move more freely between field and lab, adapting and hybridising the practices of one space for application in the other.[59] In fact, it was the very placelessness of the laboratory that drove lab-trained ecologists back out into the field. The great questions posed by Darwin, about adaptation, competition, the 'economy of nature', could not be answered by the increasing atomisation of the living organism into its constituent microscopic parts, or by physiological experiments unrelated to the conditions faced by organisms in their natural settings. For ecologists, the specificity of field places was precisely the point. Only by understanding these places, and the responses of organisms to their complex variability, could the larger biological questions of adaptation, speciation and distribution be answered.

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example, has remarked upon 19th century anthropologists' customary distinction between "data collectors and theorists who analysed communications from a distance" (Kuklick 2008: 159), whilst Martin Rudwick has observed a similar division in 18th century geology, and which was already under challenge in the 19th (Rudwick 2005: 41).

[58] Latour 1987: 215 *et seq.*

[59] Kohler 2002b.

Many investigations of field science begin by pointing to the importance of place, its complex variability, and specificity, the importance of being *in the field* for generating particular kinds of knowledge.[60] They frequently end by displacing inquiry from difficult-to-discern matters of individual field experience, to collective discourses and social practices, usually carried on elsewhere than the field, in lecture halls, museums, scientific society meetings and conversaziones. Whilst acknowledging the importance of 'excursion cultures' and the instrumentation of field study, they rarely consider the embodied experience of field excursion or field study. By examining the detailed field practices of British naturalists and ecologists closer to home, this thesis considers not only the social expression of the resulting frameworks of knowledge but the cognitive and epistemological importance of the field as a place of scientific knowledge-making.[61] As the thesis shows, especially in chapters 3 and 6, the interior debating spaces of local natural history regulated and formalised the unruly chaos of field experience, but the entire purpose of this social mediation was to facilitate practice in the field. Meetings and lectures concerned objects and experiences derived from the field, to which participants looked for authentication of their subject and their scientific practice. Both naturalists and ecologists immersed themselves *in the field*, in places where their objects of study could be found; where they could perform the rituals of scientific observation, but also where they could embrace the sensory and intellectual experience of moving and observing within particular environments of scientific study. Both indoor and outdoor practices together constituted the *habitus* of ecological technique and experience.

As Dorinda Outram suggests of natural history in general, field sciences like ecology are "inseparable from movement through space, inseparable therefore from bodily involvement."[62] In other words, embodied knowledge is knowledge *in place* (Fig. 1.6 overleaf).[63] Even so, embodied involvement in place, and the consequent subjective aspects of knowledge formation, have generally been ignored by historians of science, in favour of social critique, and the study of visual science as representation. But social knowledge is also subjective knowledge, embodied in private experience. Martin Jay, who contributed significantly to what he called the 'academic juggernaut' of the 'visual turn' has argued for a

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[60] Finnegan 2005; 2009; Naylor 2002.

[61] In his study of 19th century Cornish naturalists, for example, Simon Naylor (2002) claims that the field site was defined by the indoor, social and institutional spaces of local natural history. In fact, this thesis suggests, if such a doubtful polarity is to be recognised, it should be cast the opposite way.

[62] Outram 1995: 255.

[63] For more on Massart's use of stereo photography in ecology, see *Photographic associations in* Chapter 3.

separation between representation and visual experience. "The recognition that sight is entangled with psyche suggests the limits of an exclusively culturalist approach," he suggests, and "sight, no matter how seemingly disincarnated it may appear in certain scopic regimes, never loses its links with the flesh in which it is embedded."[64] Once you ask what ecologists as field scientists actually *do,* embodied action becomes an inevitable focus of attention; knowledge and understanding themselves become embodied, both in the individual subject and in the commonality of shared actions, the *habitus* of ecological practice.[65]

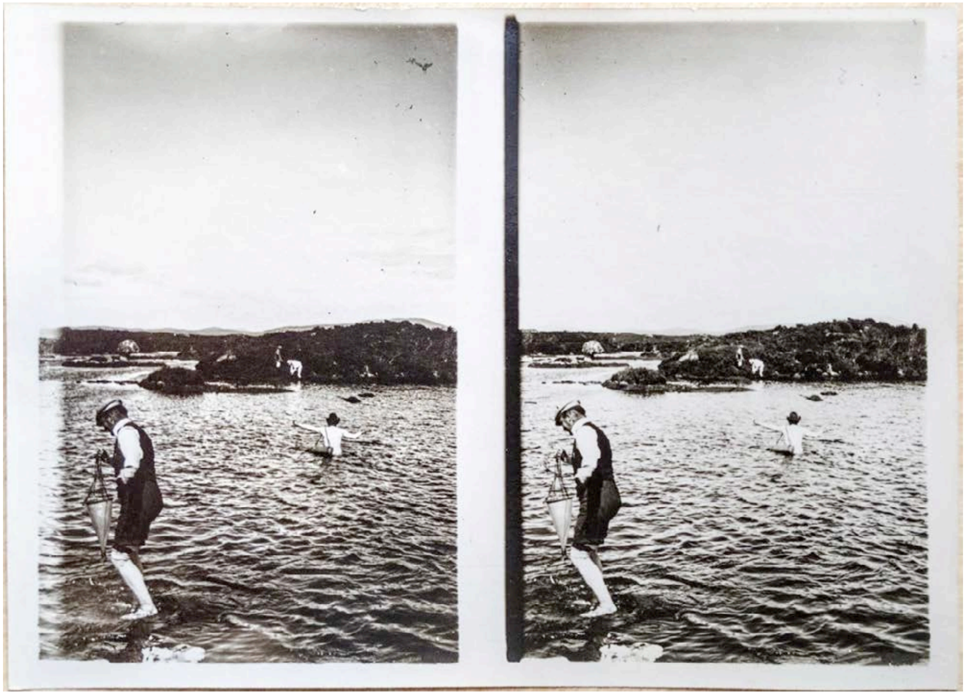

Fig. 1.6. Jean Massart. *'Aquatic botany!' Connemara, International Phytogeographic Excursion, 1911.* BES Tansley Photographic Collection. MAS/80.

Importantly, ecologists' conviction in *the field,* as the uniquely authenticating locus of ecological knowledge, was articulated in methods of observation that were pre-eminently visual in character and often reliant on photographic technologies for registering and communicating ecological objects and knowledge. Chapter 5, which examines the detailed

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[64] Jay 2002: 276.

[65] Taylor 1993: 50, 53. Bourdieu, to whom we owe the notion, explicitly avoided the subjective phenomenological implications of the concept of *habitus* as practical knowledge which, he wrote, "has nothing to do with phenomenological reconstitution of lived experience" (Bourdieu 1977: 4). Once we begin to speak of embodied practice, however, it seems to me that such implications are inevitable.

visual methods of ecological field practice, is especially concerned with this question.[66] Chapter 6 further extends my inquiry into the experiential foundations of field science to consider a shared ground of collecting and photographic practices, re-connecting ecology with a wider tradition and community of field practice in natural history. This thesis is not a phenomenological investigation, however, which should properly be understood as entailing a philosophical inquiry into the constitution of experience as a project in itself. Rather, the thesis presents an ethnographic history of photography's permeation through the practices of early scientific ecology, taking seriously what ecologists actually did with regard to photography, reading past their published accounts to understand the articulation of knowledge in social and scientific practice. To the extent that it explores the *experience* of ecological and photographic practice, as central to the early conduct of scientific ecology, the thesis is also a history of scientific subjectivities, excavating the visuality of ecological skill and experience among its practitioners, even as these were enfolded within the social and disciplinary networks of scientific discourse. In both these guises, the thesis is less about the ontology of images, the constitution of perception or the nature of visual representation than it is about the practices of image makers and image users, the exchange and circulation of visual artefacts, material images capable of display and circulation, and expected to communicate knowledge. It interrogates the work that images were asked to perform, in the dissemination and regulation of knowledge, as rhetorical tools, methodological 'tools of observation', and as tokens of experience and embodied cognition.

Botany into ecology

The thesis, then, is about visual knowledge and about scientific practice. More specifically, it is about the role of visual practices — especially photographic practices — in establishing and promoting ecology in Britain, as a new kind of knowledge and as a new scientific discipline, between around 1895 and 1939.[67] My purpose is not to write a new history for

[66] Though not always explicitly stated, my thinking on place and embodied cognition has been influenced in imprecise but decisive ways by J.J. Gibson's (1979 [2015]) notion of 'ecological perception', by the phenomenological inclinations with regard to place and movement evident in Tim Ingold (2000) and Christopher Tilley (1994) and, in the field of embodied cognition, by Lawrence Shapiro and others (see, for example, Wilson and Foglia 2011; Shapiro 2011; 2015.)

[67] In the period of its establishment and early development, 'ecology' had a much more restricted meaning than it does today. Its meanings broadened through the second half of the 20th century to encompass influential ideological and political discourses of nature conservation and environmental protection, the management and exploitation of natural resources, and of appropriate social and political organisation. These are important perspectives, requiring their own histories, and there is much still to be written about the entwined histories of ecological science and ecological politics, not

ecology, or to rewrite its origins and development. Nevertheless, to profess an historical approach is to take a position in relation to the history as it is already written and this thesis aims to subject that history to scrutiny from a new perspective, to provide an historical study in visual science and culture. Writing in 1998, Pascal Acot observed that fewer than twenty books had been published on the history of ecology worldwide, most of them after 1985. Even in that short period, ecology's history was approached from a number of distinct perspectives but none which registered a visual foundation for ecological knowledge and practice. The most widely cited general history of ecology in English, prior to Acot's remark and since, is probably Donald Worster's *Nature's Economy: The Roots of Ecology* (1977; 1994). Worster's is a history framed in terms of competing, broad conceptions of the natural world, from antiquity to the 20th century. It treats scientific ecology only briefly, with a focus on a particular early American school, centred on the figure of Frederic Clements at the University of Nebraska. Ronald Tobey (1981) has recounted the history of this school and its ideas in more detail, aiming to establish its position as the "founding school of American plant ecology". Gregg Mitman (1992) provided a similar service for a 'Chicago school' of ecology, in a history of religious and social foundations for the political and ethical ideology of cooperative nature, in a half-century framed by two world wars. Other studies have yielded more specific histories, for population ecology (Kingsland 1985; 1995), or the relationship of plant ecology to German botanical laboratory science at the end of the 19th century (Cittadino 1990). Joel Hagen (1992) has traced the 19th century antecedents and 20th century history of the ecosystem concept. Robert McIntosh (1985) attempted a comprehensive overview of the history of ecological ideas, whilst John Sheail (1987), in a history of the British Ecological Society, traced the social and institutional origins and development of the discipline in a British context. Kaat Schulte Fischedick (1995) has also written about early British ecology, in a comparative study of vegetation science from a constructivist socio-historical perspective.[68]

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least the story of photography's role in the rapid growth of 20th century environmentalism. Here, however, I am concerned with laying foundations for these larger historical narratives, by establishing a visual and photographic history for the scientific and disciplinary formation of ecology before the age of environmentalism ever took hold.

[68] Acot 1998: xvii. Worster 1977, Worster 1994; Tobey 1981; McIntosh 1985; Sheail 1987; Mitman 1992; Kingsland 1985, Kingsland 1995; Cittadino 1990; Hagen 1992; Schulte-Fischedick 1995. Malcolm Nicolson has also contributed a number of papers on the prehistory of ecological vegetation science, and some of its early 20th century controversies (Nicolson 1987, Nicolson 1989, Nicolson 1990, Nicolson 1996, Nicolson 2013; Nicolson and McIntosh 2002). Two important volumes on the classification of vegetation by Robert Whittaker (1962; 1978) also include substantial historical components. Studies have also appeared in French (Acot 1988; Drouin 1991; Deléage 1992). Real and Brown 1991 provide a history of classic papers in ecology, with limited commentaries focussing

Since 1998, these texts have been supplemented by a handful more, including an account of early British ecology as an Imperial project (Anker 2001), an exploration of the history of ecology as a biological border science, moving between field and laboratory (Kohler 2002a), and a history of selected American institutions in ecology's 20th century (Kingsland 2005). Most recently, as editors for a volume of essays, Schwarz and Jax (2011) have attempted a wide ranging survey of ecological concepts and their histories, whilst Frank Egerton (2012) has traced the roots of ecological ideas into antiquity. Smaller studies have also been made of the social networks of early ecologists in particular geographical contexts (eg. Cameron and Matless 2011) and of the relationship between early British ecologists and amateur natural history (Lowe 1976; Alberti 2000, 2001). Histories of British nature conservation are also available (Sheail 1998; Sands 2012) and some researchers have touched on the relations between ecology, nature conservation and their institutional frameworks (Bocking 1997; Matless 1998).[69] Even from this modest historiography, it is clear that ecology's history may be written from a wide range of perspectives, with scientific origins drawn equally persuasively from natural history, geographical botany, laboratory physiology, limnology and marine biology, and entangled social relations emerging out of amateur natural history, professional botanical exploration, academic biology and colonial networks. Nevertheless, the visual basis for ecological understanding and representation remains entirely unexamined in the histories of biology and ecology.

How one traces the origins of ecological thought and science is clearly open to debate. However, the first ecological voices were raised in favour of plant ecology and, since this thesis takes scientific *practice* as its subject, it follows the ecologists themselves. The first recognised route to ecology came from botanists working in the traditions of 19th century plant geography, and this remains the clearest pathway in conceptual development and scientific practice to the emergence of a 'self-conscious' ecology at the beginning of the 20th century.[70] If a scientific discipline can be said to have such a sense of its own identity, located

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mostly on later 20th century ecological practice; Bocking 1997 takes in ecology's institutional history in the second half of the 20th century; Kormondy and McCormick 1981 reviewed ecological science in the late 20th century with limited historical notes.

[69] Anker 2001; Kohler 2002a; Kingsland 2005; Schwarz and Jax 2011; Egerton 2012; Cameron and Matless 2011; Lowe 1976; Alberti 2000, Alberti 2001; Sheail 1998; Sands 2012; Matless 1998.

[70] The term 'self-conscious ecology' was first coined by Allee (1949: 42-43), and was usefully deployed by McIntosh (1985) to distinguish the development of ecological science into a self-conscious phase, in which practitioners thought of themselves specifically as ecologists, as distinct from the great range of 'ecological' ideas, many of which have their own histories which can be traced in some form or other far into antiquity. See, for example, Worster 1977, 1994, and Egerton 2012.

close to its centre will be a statement of Methods and the first such statement came in 1905, with the publication of *Research Methods in Ecology* by the emerging leading voice of North American ecology, Frederic Clements[71]. That volume was limited to the theory and methods of plant ecology and was received by other plant ecologists as "the most ambitious and most important general work on Ecology that has been published during the last seven years".[72] The work's important 1898 predecessor was Andreas Schimper's *Pflanzengeographie auf physiologischer Grundlage* which, together with Oscar Drude's *Handbuch der Pflanzengeographie* (1890), and *Plantesamfund: Grundtræk af den økologiske Plantegeografi* (1895) by Danish botanist Eugene Warming, was widely recognised as a foundational text for the discipline.[73] Clements self-consciously aligned his own methodological text with these "three works of great importance,"[74] and thereby grounded ecology in a prehistory of botanical and physical geography originating with Alexander von Humboldt at the beginning of the 19th century. It was a tradition that Charles Flahault would have recognised instantly as the theoretical and practical foundation for his own mapping project. Most scholars have since followed early practitioners like Clements and Flahault in regarding this trio of texts as markers for the disciplinary advent of scientific ecology, and ecology as a transformation of 19th century phytogeography, the science of the distribution and diversity of plantlife.

Humboldtian plant science was a new kind of botanical geography, which distinguished itself from the dominant 19th century paradigm of botany by its primary object of study. Most 19th century botanical study was rooted in classification, concerned with the forms and taxonomic relations of plant species. Throughout the century, botanical geographers sought to discover and catalogue new species, and to understand their patterns of distribution and dispersal. In the second half of the 19th century, as natural history was transformed into laboratory science, academic botany became predominantly concerned with questions of specific morphology and physiology rather than field investigation.[75] Botanical field expeditions were devoted to collecting specimens for use in laboratory study, as evidence for phylogeny and systematic classification. By contrast, Humboldt's ecological successors took

[71] Clements 1905.
[72] Blackman and Tansley 1905: 199.
[73] Schimper's text (Schimper 1898) was published in English translation as *Plant-geography Upon a Physiological Basis* (Schimper 1903); Warming 1895.
[74] Clements 1905: 3.
[75] Allen 1976 and Nyhart 1995 both chart aspects of this transition, though a more complex picture emerges when a larger view is taken of biological science, for example, by Nyhart 2009 and Bowler and Pickstone 2009.

as their object of study not individual plant taxa but vegetation *en masse*. They rejected the dominance of laboratory morphology and systematics and promoted a return to the field, to study plants as they grow together in their natural settings. Botanical geography, they insisted, must go beyond purely descriptive, floristic accounts, to consider the environmental and physiological mechanisms of plant distribution and vegetation development. This distinction between so-called *floristic* phytogeography, or taxonomic botany, and the science of vegetation is a critical one for a study of visual ecology, and one that asserts itself repeatedly in this thesis. The distinction first became important to a small number of British botanists in the late 1890s and the dates of this study are drawn to encompass the period of its growth to dominance in British ecology. The beginning and end of the period are marked by the publication of two particularly significant texts for British vegetation science. The first, published in 1895, was Eugene Warming's influential book *Plantesamfund: Grundtræk af den økologiske Plantegeografi*, published initially in Danish and soon encountered by British botanists in German translation.[76] When Arthur Tansley, Britain's most influential early ecologist, came to edit the first extensive study of British vegetation in 1911, he dedicated the volume to Warming as the 'Father of Modern Plant Ecology', and to Charles Flahault for his inspiration to the project of vegetation survey in Britain.[77] The second, Tansley's final great synthesis of British vegetation *The British Islands and their Vegetation*, was published in 1939 and provided a summation of Tansley's own life-work as an ecologist and of this first phase of ecological science in Britain.[78]

Mapping the thesis

Chapters 3 and 4 of this thesis, in particular, are given to a consideration of the rhetorical and evidential values of photography as a technology for looking at and representing vegetation, and its role in establishing ecology, as a scientific practice and as an epistemological community. I begin in chapter 2, however, by establishing a visual history for ecology, re-examining some of the key moments and figures of its 19th century antecedents in phytogeography and physiological botany. When ecology emerged as a 'self-conscious' discipline at the beginning of the 20th century, it did so in the guise of a new science of

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[76] Warming's *Plantesamfund* was made widely available following its translation into German as *Lehrbuch der ökologischen Pflanzengeographie* (Warming 1896); the first English edition appeared (much modified) only in 1909, under the title of *Oecology of Plants: an introduction to the study of plant-communities.* (Warming 1909).

[77] Tansley *et al* 1911a.

[78] Tansley 1939.

vegetation, in contradistinction to botany's fixation on the species as the natural unit of biological study. This chapter traces the development of ecology from its roots in 'Humboldtian' concepts of 'vegetation', to the first modern ecological vegetation surveys undertaken by British ecologists in the late 1890s. Those roots have been traced by others, but this chapter reconsiders the history from the perspective of visual knowledge. It recounts the work of selected 19th century botanists whose published accounts of botanical geography and vegetation studies reflect a strongly visual mode of scientific observation.

In Britain, following early studies of vegetation in the late 1890s, a small group of botanists embarked upon a concerted, strategic effort to promote further vegetation study, and to develop new methodological and theoretical principles for ecology. Chapter 3, which deals with the social articulation and exchange of ecological knowledge, its disciplinary communities and institutions, makes clear the implacable sociality of scientific knowledge in general, whilst also emphasising its continuing visual character in ecological practice, and the importance of visual — especially photographic — mediation in disciplinary development and expansion. In this chapter, the social and institutional foundations of ecology and collective empiricism are explored, with a focus on the professional and amateur social networks in which ecologists were particularly active. The chapter places the growth of ecological vegetation survey in the wider context of a generalised survey ethos, encompassing not only botanical science but geology, anthropology, astronomy, meteorology, antiquarianism, and numerous other fields of study. In particular, the establishment and fate of related photographic collections for botany and ecology are described and interrogated for their epistemological and disciplinary effects.

Chapter 4 gives particular consideration to the importance of print publication in carving out a place for ecology as a professional science in competition with established botanical practice. In both the USA and in Britain, the emergence of ecology was marked by a pronounced shift in the character of illustrations carried by botanical journals, reflecting the shift from taxonomic and morphological botany to the vegetation studies of ecologists. The chapter surveys the print cultures of early ecology publishing, especially in journals, textbooks and monographs on vegetation. The latter included a range of major, photographically illustrated publishing projects, dating from the 1890s to the 1930s, which demonstrated a marked ambivalence in the transition from floristic to ecological phytogeography in a European context, in contrast to Anglo-American vegetation ecology.

Chapters 5 and 6 return to consider the visual character of ecological knowledge, first through an examination of ecology's methodological foundations as a field science, and then in a related investigation of the subjective experiences and encounters of ecologists, within the context of a broader realm of related natural history field studies. Both chapters emphasise once again the central importance of 'the field' as the location for the construction of ecological knowledge. Chapter 5 concentrates on the development and application of early ecological methods, and brings home the embodied and subjective foundations of ecological study. In this chapter I explore in particular the visual practices of field ecology, focusing especially on the uses of mapping and related drawing practices, and the role of photography as an instrument for scientific observation and record. I use the experience and methods of vegetation survey and mapping to think about the relationships between cartographic vision and photography in the embodied cognition of ecological fieldwork.

Finally, in chapter 6, I return to the material and visual practices of ecology, to underline a continuity with the wider context of field natural history. In so doing, the role of material practices of display and exchange come to the fore, alongside the performative and embodied character of natural history field science. Taking examples from the practices of Victorian and Edwardian natural history, and from the new ecology, the chapter places photographic exchanges in the context of broader material practices of collecting and exchange in natural history specimens. Through a discussion of amateur naturalists and their societies, in the context of 'rational leisure', I explore the social and subjective motivations for these forms of natural history practice. In a discussion of published accounts of field practice in natural history, with specific case examples of photographic practice, I explore the experiential foundations collecting and exchange, and place photography within a broader economy of knowledge and material culture.

2. New Natural Landscapes: Nature tracing its own shape

The study of the vegetation has thus become a study of plant associations.[1]

Eighteenth and nineteenth century botany was a science of collecting and naming. Botanical collectors travelled the globe, returning with specimens for describing and naming under the Linnaean system of taxonomic nomenclature. Flowering plants were named and classified according to the form and structure of their reproductive organs — in other words, their flowers. The resulting 'floristic' botany was applied to describe the vegetation of a definite geographical area by listing the species present. An exhaustive list, arranged according to taxonomic similarity, was referred to as the *flora* of the area in question. A huge number of 'floras' have been and continue to be published on this basis. For most of the 19th century, serious so-called 'philosophical botany' was equated with the investigation of these systematic and taxonomic relations. Facilitated by colonial opportunities, as well as localities closer to home, botanists investigated the geographical distribution of species, where they originated and how they spread, and how they could be grouped into floristic districts or realms. Inquiries into the 'vegetation' of a region commonly took the form of expanded species-lists and arithmetic analyses of the relative numbers of different taxa.[2] More recently, under the influence of novel laboratory-based methods from Germany, academic botany had become dominated by studies of plant morphology and physiology. The central epistemological construct for all these enterprises remained the *species*, not the massed phenomenon of vegetation asserted by Humboldt and his successors. Few if any 19th century botanists doubted the real existence of species as natural groupings of affiliated organisms,

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[1] Smith 1899.

[2] This kind of 'philosophical botany' was epitomised by the century's greatest figures in British botany, Joseph Dalton Hooker and Hewett Cottrell Watson. Charles Darwin referred to Hooker as "our best and most philosophical botanist" (Darwin to J. L. A. de Quatrefages de Bréau, 5 December 1859, Darwin Correspondence Project, "Letter no. 2571," http://www.darwinproject.ac.uk/DCP-LETT-2571 [Accessed 28 Mar 2016]). The terms 'philosophical botanist' and 'philosophical naturalist' were active throughout the 19th century, to indicate both a disinterested and rational scientific persona and a scientific approach to studying the natural world which sought general causes and laws for the forms and geographical distribution of organisms, rather than the simple 'fact-finding' of observing, naming and classifying species. See Stevens 1994: 205-6; Endersby 2008: 41-42 on 'philosophical botany'. 'Philosophical naturalist' was a description applied amongst naturalists, both to themselves and to others who they felt had earned the esteem of their colleagues by demonstrating appropriate scientific conduct. Darwin applied the term to himself and to a number of others, in his both his published work and in his private correspondence (Sloan 2003).

but even the most 'philosophical botanist' accounted vegetation as the simple aggregation of plants, whose description was exhausted by naming and counting species.[3]

This kind of taxonomic botany shared some common ground with early ecology; in particular, both were concerned with phytogeography, the description of regional floras and the distribution of plant species and groups. But the two differed markedly in the way they saw plant-life, and in how they sought to describe what they saw. Ecologists did not reject outright the knowledge acquired by floristic botany but they rejected its taxonomic basis and its narrow focus on individual species. Promoting a new kind of phytogeography, one focused on *vegetation* as an object of study in its own right, ecologists emphasised the *association* of species one with another, and with the environmental conditions of the places they grow. This required them to go out into the field, to observe the phenomena of plants *en masse,* to look at vegetation as a discernible entity in itself. However, this shift in the conceptual and visual basis for botany did not happen overnight, as ecology woke into self-conscious life at the end of the 19th century. Views of massed vegetation were sought by others in the 19th century, beginning with Alexander Von Humboldt (1769-1859), but descending in a broken lineage to the first recognisable ecologists of the 20th century. In this chapter, therefore, I want to revisit the 19th century botanical antecedents of ecology, to look again at its key figures and milestones from a visual perspective; to trace the early development of ecology as a science

[3] After Linnaeus, most naturalists treated the species concept as an essentialist notion concerning the fixed types of recognisable natural objects; a foundational idea, supporting a superstructure of ordered creation. For evolutionary biologists this necessarily also entailed questions of phylogeny, in addition to the classificatory framework already provided by Linnaean taxonomy. Linnaeus, Darwin and Hooker all expressed doubts about the species construct but it remained at the heart of their scientific practice and that of their successors, both professional and amateur natural (biological) scientists. Evolutionary theory should have robbed the species-concept of its fixity and emphasised instead the generative and transformative properties of living organisms. In practice, the foundational status of the species remains. It has become a hybrid notion, allowing development and transformation from one kind to another, but remains the central principle for differentiating and grouping organisms based on shared characteristics. Despite its customary familiarity among naturalists and biologists of all kinds, the concept of a 'species' had in fact proved distinctly unstable. Even Linnaeus, celebrated as the great architect of modern taxonomy, propounded different notions of the species at different stages in his career (Richards 2010: 56 et seq; Wilkins 2009: 70 et seq). Darwin, whilst generally subscribing to a realist view of the species, in *On the Origin of Species* he famously declared species to be arbitrary if convenient categories (Richards 2010: 71), and changed his views as to the nature of species (Wilkins 2009: 130 et seq). Darwin's close friend Joseph Dalton Hooker, who worked tirelessly to regulate the recognition, naming and description of species (Endersby 2008), was also by no means convinced of 'species' as a clear natural category (Wilkins 2009: 126). For variations on this theme, see Dupré 1993; Wilkins 2009; and Richards 2010. For a detailed recent account of the history and philosophy of natural classification, see Wilkins and Ebach 2014.

founded on visual empiricism, with all the subjectivity and aesthetic complexity of response that such a visual perspective might imply.

Nature tracing its own shape: Visual and natural knowledge in Humboldt

Few scientists have the distinction of giving their name to a realm of scientific knowledge. We speak readily of Newtonian mechanics, Darwinian biology, or Linnaean taxonomy but to Humboldt goes the distinction of defining an entire scientific world-view. The descriptor 'Humboldtian science' has become a commonplace in the history of science and Humboldt's influence is traced across a wide range of modern scientific disciplines, from physical geographies to climatology, mathematics, natural history and botany.[4] Perhaps the last general natural scientist who felt able to unify the project of scientific understanding with a visual, aesthetic response to the phenomenal world, Humboldt's aspiration was for a general 'physics of the world', an account of the competing forces of nature responsible for shaping the earth and its appearances.[5] An essential part of a 'general physics', he said, was a scientific geography of vegetation. That geography would be founded on a visual apprehension of the natural 'physiognomy' of vegetation. In 1806, in *Ideen zu einer Physiognomik der Gewächse*, he proposed for the first time a general science of vegetation, clearly distinguishing it from a floristic botany based in Linnaean taxonomy.[6] The physical character of a landscape was determined, he said, largely by its vegetation cover and, in seeking to understand the 'physiognomy' of that landscape, the botanical geographer "must be guided solely by those elements of magnitude and mass from which the total impression of a district receives its character of individuality."[7] Understanding the physiognomy of vegetation required attention to whole units of vegetation in themselves, not as simple aggregates of individual plants, and

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[4] The term 'Humboldtian science' was coined by Susan Cannon (1978: ch. 4); see also Dettelbach 1995.

[5] Dettelbach (1995: 228) translates Humboldt's *Physik der Erde* (*physique du monde* in the French translation for 1905) as 'terrestrial physics', which may carry somewhat different connotations, especially in natural history where 'terrestrial' is often opposed to 'aquatic' or 'marine'. Jackson (Jackson 2009a: 42) is clear that "Humboldt's *physique du monde* translates as 'physics of the earth.'"

[6] Malcolm Nicolson (Nicolson 1996: 290) also recognises that, for Humboldt, vegetation constituted "an object of inquiry per se", and that this conception of vegetation constituted a new practice, distinct from Linnaean floristic botany. Nicolson suggests further that Humboldt regarded plant geography as "a crucial link between the natural sciences and the human sciences… a central element within Humboldt's programme for 'la physique générale'."

[7] Humboldt 1850: 220-221. Quotations from Humboldt's *Ideen* are taken from its English translation as *Ideas for a Physiognomy of Plants*, in ibid.: 210-352, translated by Emil Otte and Henry G. Bohn.

the taxonomist's rational arrangement of plants into higher groups such as genera and families was no help here.

> The systematising botanist…separates into different groups many plants which the student of the physiognomy of nature is compelled to associate together. Where vegetable forms occur in large masses, the outlines and distribution of the leaves, and the form of the stems and branches lose their individuality and become blended together.[8]

Malcolm Nicolson has suggested that the differences between Humboldt's vegetation science and Linnaean natural history amounted to a Foucauldian epistemic revolution at the end of the 18th century.[9] A straightforward opposition between Humboldtian vegetation science and Linnaean taxonomy, however, would be mistaken. Humboldt was proposing a new object of study which the Linnaean system was incapable of recognising. But this should not be interpreted as outright rejection of Linnaean systematic botany. On the contrary, Humboldt regarded the systematic understanding of nature's forms to be an essential foundation for a science of vegetation and spent much of his career engaged in taxonomically related botany. "This knowledge of the forms which make up organized beings is no doubt the principal basis for descriptive natural history," he said.[10] In making his claim, Nicolson also places Linnaeus and Humboldt on either side of a visual epistemic divide, suggesting with Foucault that 18th century "natural history is nothing more than the nomination of the visible" whilst, with Humboldtian science, "the emphasis moved from the scrutiny of the external features of objects to the study of internal features and processes…[to]…the underlying organic cohesiveness of nature and the hidden…relationship between phenomena."[11] As Foucault suggested, Linnaean-style classifications and typologies had the effect of "limiting and filtering the visible", and its representation, to the logical abstractions of language.[12] But to place Humboldt on the far side of a Kantian reorganisation of the foundations of natural knowledge should not be taken as a claim for the removal of the visual from natural history science in the 19th century. Such an assertion is contradicted by Humboldt's clear preoccupation with the aesthetic and visual assessment of vegetation. For Humboldt,

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[8] Ibid.: 221.
[9] Nicolson 1987; Nicolson 1996.
[10] Humboldt and Bonpland 1805 [2009]: 64.
[11] Foucault 1970: 144; Nicolson 1987: 170
[12] Foucault 1970: 147.

Fig. 2.1 *Géographie des Plantes Équinoxiales: Tableau physiques des Andes et Pays Voisins.*
Alexander von Humboldt and A.G. Bonpland (1805)

vegetation was an object 'given' to the senses, in much the same way as the natural morphological structures of organisms were visible to the Linnaean botanist.[13]

In his 1805 *Essai sur la géographie des plantes*, Humboldt had already indicated how his scheme for vegetation science might look in detail. Based on his travels to South America, he constructed an intensely visual framework for understanding the topographic zonation of vegetation with altitude. He placed that zonation in a broader climatic classification of vegetation types across the South American continent and, ultimately, a world geography of plantlife. He went to considerable efforts to make systematic measurements of environmental parameters that might influence the character and distribution of different types of vegetation - air temperature, barometric pressure, altitude, light intensity and refraction, gravitational force, the blueness of the sky, atmospheric humidity, chemical composition of the air and geological information.[14] "I have attempted to gather in one single tableau," he declared, "the sum of the physical phenomena present in equinoctial regions, from the sea level of the South Sea to the very highest peak of the Andes" (Fig. 2.1).[15] The measurement of environmental conditions was important because it provided a path to understanding causation; how different vegetation types come about and why they occur where they do. The tableau, prepared from a sketch that Humboldt made more than six months after visiting the mountain, was clearly not intended as a naturalistic representation. Rather it was an abstract rendering of the complex inter-relations of vegetation with physical

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[13] This stance has important potential implications for Foucault's general thesis of revolutionary epistemic change at the end of the 18th century, and his characterisation of natural science more generally. This perspective, of epistemic revolution, is also reflected in Thomas Kuhn's account of scientific history (Kuhn 1970). Some commentators have drawn attention to Kantian idealism in Humboldtian science (the most relevant for this discussion include: Dettelbach 1995; Nicolson 1987; Romanowski 2009), but such an idealist commitment does not entail a wholesale rejection of its precursor scientific epistemologies, or of a broader phenomenology of scientific knowledge practices. As Daston and Galison (2007) have pointed out, one epistemic regime does not entirely replace another. The principle of visuality in scientific evidence and knowledge cuts across the epistemic revolutions that Foucault and Kuhn want to suggest as the fundamental structure of knowledge formation. Humboldt's 'view' of nature, and specifically of vegetation, was above all visual. For the observing scientist, one who was capable of seeing correctly, it was possible to 'encompass/take in nature at a glance' (Humboldt 1806; Humboldt 1850: 217). Foucault's and Nicolson's 'denigration of vision', as Martin Jay (1993) has called it, is inappropriate here, and a continuity of visual observation, across the divide of Foucault's epistemic revolution, may also suggest continuity in other knowledge practices.

[14] An impressive array of instruments transported with Humboldt's expedition is listed in Humboldt's *Personal Narrative of Travels to the Equinoctial Regions of the New Continent* as translated by Helen Maria Williams (7 vols., Humboldt 1818-1829, Volume 1: 34-40). The instrumentation deployed by Humboldt in his studies for the *Tableau Physique* are discussed by Stephen Jackson in *Instruments Utilized in Developing the Tableau physique* (Jackson 2009b: 221-26).

[15] Humboldt and Bonpland 1805 [2009]: 78.

forces, and their spatial expression; part of Humboldt's 'physique générale'.[16] These generalised correlations between vegetation zones and physical parameters are, nevertheless, directed here to the interpretation of visual evidence.

Whilst physical data were essential to demonstrating the relationships between plantlife and physical forces, Humboldt's physiognomic classification was also essentially visual and aesthetic. He referred repeatedly to the 'impressions' that vegetation makes upon us, and distinguished different vegetation forms in terms of their 'picturesque' appearance in the landscape "and the vivid impression produced by the grouping of contrasted forms in different zones of latitude and elevation".[17] Humboldt's claim is that it is possible to discern different forms of vegetation visually, from their massed appearance, and a painter's eye is required to apprehend and render pictorially these visible forms.[18] But the precise character of vegetation is also delineated by its dominant plants and their association with others, and of the physical forces implicated in vegetation development. This required detailed observation and measurement in an operation that was simultaneously aesthetic *and* scientific. As Michael Dettelbach has suggested, Humboldt conceived of Nature depicting itself, "tracing its own shape", to those with sufficient (albeit instrumental) powers of observation and measurement.[19] This yoking together of visual appreciation with botanical knowledge and scientific measurement confirms that, for Humboldt, "aesthetics complemented rationality."[20]

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[16] Ibid.: 64. The tableau itself was prepared still later, by an artist and then an engraver, working from Humboldt's sketch, in Paris in 1805. Humboldt, his co-author Bonpland and others made a much celebrated ascent of Mount Chimborizo, almost reaching the summit of what was then thought to be the highest mountain in the world) in the summer of 1802. Humboldt's sketch was made whilst he was in Gauyaqil in February 1803, awaiting passage to Acapulco. Chimborazo is actually visible from Guayaqil but at 140km distance could hardly be made the subject of a painting 'from nature'. (see http://www.summitpost.org/chimborazo-from-guayaquil/386105 [Accessed 21 Sep 2016]. It is tempting to imagine Humboldt, however, prompted to make his sketch by the distant presence of the mountain, a combination of visual memory and analytical reflection, as he prepares to leave Ecuador. For a timeline of Humboldt's American voyage, see A. v. Humboldt, "Philadelphia Abstract," 1804, in Terra 1958.

[17] Humboldt 1850: 349.

[18] Ibid., on p.223, for example: "Notwithstanding all the richness and adaptability of our language, the attempt to designate in words, that which, in fact, appertains only to the imitative art of the painter, is always fraught with difficulty."

[19] Ibid.: 349; Dettelbach 1999: 487. This physiognomic and visual scheme for vegetation sits within a broader framework of visually mediated science and Dettelbach discusses the *Tableau* in relation to Humboldt's other visualisations of scientific data, in particular his much analysed 'isolinear maps'.

[20] Nicolson 1987: 180. Michael Dettelbach also agrees with this position, concluding that "The most various facets of Humboldt's work can therefore be seen as an aesthetic project, a reiterated effort to define and display a sensibility or 'physiognomic eye'." (Dettelbach 1999: 502)

In Humboldt's *Tableau* (Fig. 2.1), physical data are visually arranged, in columns on either side of the central depiction of Mount Chimborazo, to reflect their spatial correlations with plant forms and vegetation. Similarly, latin plant names, entered in schematic fashion within the right-hand outline of the mountain, provide corroborative species-data. These species names offer detailed characterisation for the distinct vegetation strata that clothe the mountainsides and, like the broader vegetation zones, their positions correlate with the physical elevations at which Humboldt had recorded the plants in the field. Considering the painter's rendering of his own sketch, Humboldt described his desire to reproduce the visual effect of witnessing the vegetation first-hand.

> I thought that in the regions closest to the sea, one could represent a grove of scitaminales and palm trees with their slim trunks rising upwards. In this tableau, the eye can see the limits of these regions: there are fewer and fewer palm trees among the other trees, and the trees are gradually replaced by herbaceous plants, and these are displaced by grasses and cryptogams.[21]

The image of the mountain and its vegetation cover turns out to be representational, after all, of Humboldt's visual experience in the Ecuadorian landscape.

What Humboldt achieved here was to provide a threefold evidence base, three forms of data - visual, botanical and physical - as a triple support for his observations on the physiognomy and physical relations of vegetation. The key insight of Humboldt's vegetation science was to discern the visible phenomena of vegetation as real expressions of complex interactions between living organisms and their physical environment. To describe this complex of phenomena in a 'physiques générale', it was necessary to account for both organisms *and* physical factors, as parts of a complex whole. But verbal description alone could not hope to communicate what the educated scientific eye has seen in the field[22]. Neither could raw scientific data provide adequate insight into what has been observed. Humboldt's species-data were also of little help, on their own, in characterising the detailed physiognomy, composition or structure of any particular vegetation community. The apprehension and identification of vegetation types was emphatically a visual matter. It was a matter of perceiving 'at a glance', in the manner of a painter's eye, or of one already experienced in such visual observation and judgment.[23] For this, Humboldt must provide

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[21] Humboldt and Bonpland 1805 [2009]: 81.

[22] Ibid.: 223.

[23] Dettelbach (1999: 494), has suggested that, for Humboldt, "The aim of the true and proper 'view of nature' was 'to comprehend Nature in a *single* glance". Dettelbach gives no reference for Humboldt's use of the phrase 'at a *single* glance' but the phrase 'at a glance', which implies something close, is rendered in a similar fashion in most translations. In Humboldt 1849: 13, and Humboldt 1850: 217, the

visual argument, to confirm the reality of the observed object that is *vegetation.* Upon this complex foundation of visual observation, scientific naming and measurement, the whole future of vegetation science and plant ecology would be founded.

The General Physiognomies of Anton Kerner von Marilaun

Malcolm Nicolson has traced the legacy of Humboldt's vegetation science, through the 19th century, in the work of a number of German-speaking botanists.[24] Most early European and American ecologists also traced the origins of their science from Humboldt, with credit for refinements accorded variously to a range of other 19th century plant geographers, including Nicolson's German botanists.[25] Different accounts emphasise the importance of different members of the lineage, depending on which aspect of phytogeography is under consideration. August Grisebach (1814-1879), for example, was generally celebrated for bringing basic terminological clarity to the science of vegetation, whilst Anton Kerner von Marilaun (1831-1898) probably most closely reflected Humboldt's conceptual and methodological approach. For our purposes, more importantly, it was to Kerner that British phytogeographers looked in the early 1890s for a modern account of the history and scope of their science. Like Humboldt, Kerner demonstrated the central importance of visual observation and representation to the study of vegetation. The pictorial strategy of his two large volumes on *The Natural History of Plants* itself marked a significant development in the visual representation of vegetation in the 19th century.[26]

Educated in Vienna, initially in medicine, Kerner was professor of botany at the University of Innsbruck and then professor and Director of the Botanic Garden and Museum in Vienna. His early career included a period teaching in Budapest, during which time he was

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phrase is given as 'at a comprehensive glance'; Bauer (1852) has 'at a glance'. This phrase crops up repeatedly in the history of scientific visualisation, Lorraine Daston (2008) briefly discusses the phrase 'at a glance' and its relationship with Michael Polanyi's notion of 'tacit knowledge' (Polanyi 1958), in an enlightening discussion on scientific observation. It is phrase that crops up repeatedly in early plant ecology (see chapter 5 of this thesis for examples).

[24] Nicolson 1996.

[25] In a rapid survey of early ecological literature covering the subject's own history one can find such credits in the following: Warming 1895; Schimper 1898; Smith 1899; Flahault 1901; Clements 1904; Moss 1910; Drude 1913; Braun-Blanquet 1927 [1932]; Tansley 1947.

[26] Originally published in German as *Pflanzenleben* (Kerner 1888-91) Kerner's volumes on *The Natural History of Plants* appeared in an English translation in 1895 by botanist and (subsequently) ecologist Frank Oliver (Kerner 1895), with assistance from (among others) Arthur Tansley who came to be regarded as the leading figure in British ecology for most of the fist half of the 20th century. The translation itself was largely undertaken by two of Oliver's female students, Lady Marian Busk and Mrs. M. F. Macdonald. The translated volumes appeared in numerous editions over the next decade.

commissioned by the government to collect plants in parts of eastern Hungary and Transylvania, which formed the basis for much of his *Das Pflanzenleben der Donaulander*.[27] Published in 1863, this volume made Kerner famous as an Austrian botanist and has been characterised as "the immediate and direct parent of all later works on plant ecology."[28] Kerner followed Humboldt closely in this work, clearly demarcating a sub-discipline of plant geography for the study of vegetation along physiognomic lines, and directly naming this new botany of plant formations as 'Plant Physiognomy', underlining the visual basis for its assessment. Kerner was keen to push the physiognomic study of vegetation forward from Humboldt's foundations. His later work, especially, encompassed wide-ranging researches in plant physiology, growth and reproduction, classification and phytogeography, as the widest possible basis for understanding plant-life, environmental response and adaptation. In this earlier volume, however, the aesthetic basis for plant physiognomy, so evident in Humbodlt, is also apparent. He opened his description of an excursion to the Hungarian prairie with a long (6 pages) and richly visual appreciation of the landscape, its topography, its light, its weather and even its herds of cattle and horses. His accounts were also richly anecdotal. In the midst of his introduction to the Hungarian Lowlands, for example, Kerner recounted a startling landscape mirage and was forced to question what he saw.

> As the line of the horizon appears not as a straight line but shimmers in a wavy line through the influence of the trembling layers of air...so the bit of prairie around the cabin took on not only the contours but also the dark blue-green color of woodland.[29]

It is relatively easy to dismiss such illusions and to distinguish them from 'normal' conditions for viewing the landscape, and this is precisely what Kerner did in his subsequent text. It is striking, however, that such experiences left unshaken Kerner's confidence in visible physiognomy as the basis for vegetation classification. This confidence carried an implicit conviction in the application of experienced vision, of 'trained judgement',[30] to ensure clear and rational distinctions between real and fictive visual phenomena. An experienced vegetation scientist must make distinctions between plant communities based on the variability of their visual appearances, understanding which variations are significant for classification and which are 'illusory' and might lead to faulty community diagnosis. The application of such experienced vision is a consistent theme in the development of ecological

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[27] Kerner 1863.
[28] Kerner 1863 [1951]: vii.
[29] Kerner ibid.: 17-18.
[30] See Daston and Galison 2007: 309-362.

expertise and, although it often went unremarked, it underpinned much of the basic methodology for plant ecology and its subsequent development as a discipline. Skilled vision was recognised as a general attribute of the expertise and experience of an ecologist. Kerner, for example, was remembered by one obituarist:

> Trained from early youth to observation in the field, thoroughly familiar with the Central European flora, gifted with a keen eye for the salient features of vegetation and, at the same time, with an analytic mind ready to break up the general aspect in which a given vegetation presents itself into its elements, he was eminently fitted to develop that particular branch of phytogeography which deals with the association of plants in so-called plant-formations.[31]

Kerner's visual plant geography went beyond the recognition of different types of vegetation, however. He was also aware of the dynamic character of vegetation, anticipating ecological concepts such as succession and zonation, fifty years in advance of their common use.[32] He described the transformation of aquatic to terrestrial habitats by reed colonisation, and their subsequent transition to dry grasslands. He also recognised the influence of human intervention in such dynamic processes, in the reclamation of swamps by land-raising and drainage.[33] In the formation of vegetation on sandy soils, Kerner wrote "the three plant formations just described are not always sharply set apart from one another. Often they merge together and produce a series of unique intermediates. This intermixture is most interesting, for it shows, on close examination, that the three plant formations stand in a definite genetical relation to one another, that they are actually only steps in the development of a plant covering which gradually weaves its green and flowery carpet over the white sand of the Puszta."[34] He followed this assertion with an extended and highly visualised account of the colonisation of bare sand, and the subsequent succession of this pioneer vegetation towards a closed community. This kind of skilled vision, echoing that of Charles Flahault at the beginning of this thesis, runs through ecology's history and through this study, especially in chapter 5 which considers its detailed application in subsequent ecological method.

For the first time, in Kerner's *Das Pflanzenleben der Donaulander,* a botanist described the detailed species-composition of these visible vegetation formations, as they occurred in particular locations, rather than as a generalised exposition of vegetation types. Humboldt's physiognomic plant associations were based on just sixteen dominant plant-forms, ranging

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[31] Stapf 1898

[32] Once again, however, Humboldt was here before Kerner, having recognised the succession of different kinds of vegetation on areas of bare soil or rock. See for example, his description of the "organic forces ever ready to animate with living forms the naked rock." Humboldt 1850: 214.

[33] Kerner 1863 [1951]: 59-67.

[34] Kerner ibid.: 77-80.

from palms and cacti to lianes, ferns, heaths and grasses.[35] Whilst he recognised other species generally associated with these plant-forms, he made few observations that could be clearly assigned to particular locations or stands of vegetation. In the Danube basin, Kerner drew attention to the expressions of plant physiognomy in specific locations, detailing their visible appearances and transformations, and their typical species-composition. Kerner later followed Humboldt, however, in attempting a generalised classification of vegetation types. Based on "observations made under natural conditions, and extending over many years," Kerner wrote, he could divide plant-communities into nine groups: Forests; Scrub; Plains; Fronds; Ribbon-growths; Reeds; Carpets; Incrustments; and Felts.[36] It was this more generalised approach that emerged in Kerner's visual representation of vegetation, in his most important published work, and which presents a more ambivalent view on vegetation and its appearances.

Published relatively early in Kerner's professional career, *Das Pflanzenleben der Donaulander*, despite its strong visual emphasis, contains no illustrations. Written in the manner of a travel account, it was unlikely to gain wide circulation, and the costs of illustration were perhaps prohibitive. No such constraints applied when it came to Kerner's major two-volume work, *Pflanzenleben*, published in 1888 and 1891. By this time, Kerner was at the height of his career as Professor of Botany and Director of the Botanic Gardens and Museum in Vienna. With this work, Kerner sought to place phtytogeography in the context of an all-encompassing study of plant-life. The chief strands of late 19th century plant biology — descriptive botany and comparative morphology — "shirked the biological significance" of the plant forms they studied, he said. The investigation of plant life should proceed "from the conception of a plant's life as a series of physical and chemical processes... to elucidate the configuration of a plant in the light of its environment".[37] Plant physiology, in other words, should be directed to the discovery of the environmental factors and plant responses which determined where plants grew, and to the formation of distinct vegetation communities. For Kerner's English translators, this cry for a physiological ecology was to be the founding principle of a new science. But Kerner was also keen to launch his work into a popular sphere, to address a more general public, as well as his professional colleagues.[38] This combination of

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[35] Humboldt 1850: 221 *et seq.*
[36] Kerner 1895 Vol.2: 887-89.
[37] Kerner ibid. Vol.1: 15.
[38] This is made clear from Kerner's Preface to the English edition, in which he recounted with explicit satisfaction a story of two 'artisans' who had called upon him to see, under the microscope, some of

circumstances may explain why *Pflanzenleben*, and its English translation as *The Natural History of Plants*, was so richly illustrated, with over 2000 original woodcut drawings and forty watercolour plates (reduced to sixteen in the translated volumes). A handful of the woodcuts were drawn from photographs.

Kerner had ample opportunity here to provide visual representations which would bear out his earlier descriptive work in vegetation study. Given the broad scope of the work, however, the physiognomy of vegetation occupied only a relatively small proportion of the text and the illustrative strategy adopted throughout the book was, by turns, conventionally botanical and picturesque, reflecting the visual expectations of the twin audiences he hoped to reach with the published work. The great majority of the illustrations were devoted to particular plant species, general plant morphology and microscopic plant structure. In illustrating particular species, Kerner followed the conventions of both academic and popular botany, including the practice of traveller-botanists, presenting a species in its native habitat, or 'from nature'. A woodcut from Kerner's section on the morphology of flowers (Fig. 2.2) is typical. The species of interest is centrally depicted, with special emphasis on its distinctive morphology. Its 'native habitat' is sketched in as a generalised montane backdrop, with little or no contextual detail, even in the foreground surrounding the plants. This abstraction of the species from its ecological context creates an idealising distance from the subject, consistent with Kerner's assertion that, in scientific botany, "Comparative Morphology endeavours to trace back to a single prototype the extremely various forms exhibited by mature plants."[39] Taxonomic botany, in other words, was concerned with the re-constitution of species as a system of idealised types, even as it purported to describe from nature.

Elsewhere, Kerner showed genre woodcuts to illustrate his scientific observations, or stylised landscapes that were more expressive of the Romantic sublime than a science of vegetation. Even when he took his plate 'from a photograph', a much simplified picture inevitably resulted from its rendering as an engraving or woodcut (Fig. 2.3). Such simplified drawings communicated an abstract and stylised form for the species under attention, at the

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the things they had seen in a copy of his book in the Vienna public library. His intention, he said, had been "to write a book which might serve as a source of knowledge, not only for specialists and scholars but also for the many who, though compelled to follow some practical calling, still take an interest in science." His success is attaining this goal was endorsed further in the translating Editor's prefatory note to the English edition, where Frank Oliver wrote that "Here is a book at once attractive to the ordinary reader, and retaining unimpaired its value to trained naturalists." Kerner ibid.Vol.1: v-vii.

[39] Kerner ibid. Vol.1: 15.

expense of contextual detail in the wider vegetation unit, which ecologists would come to recognise as a plant community.

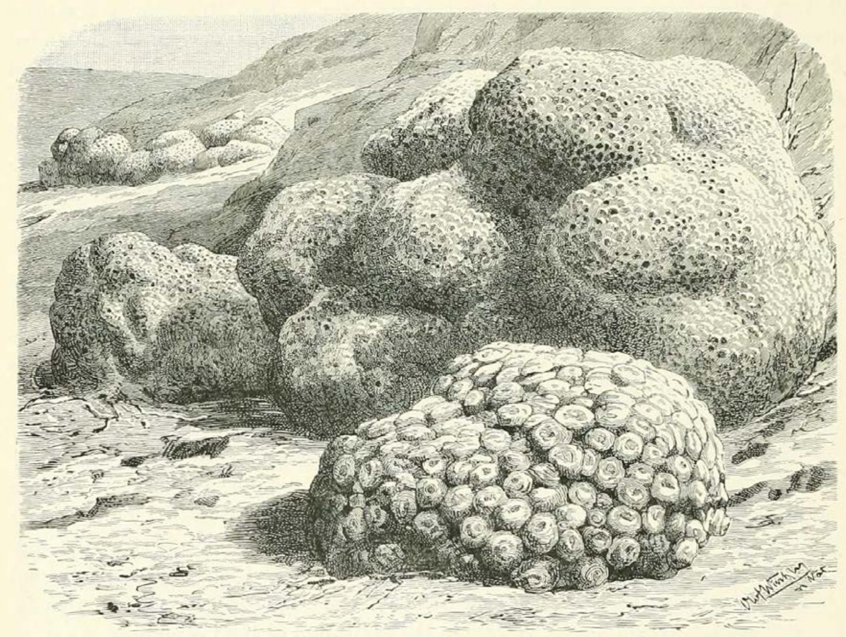

Fig. 253.—Two New Zealand Haastias (*Haastia pulvinaris* and *Sinclairii*, the latter species in front) called "vegetable sheep" by the English colonists in New Zealand.

Fig. 2.2. *Two New Zealand Haastias* from Kerner 1895. Vol.2: 188, Fig. 253.

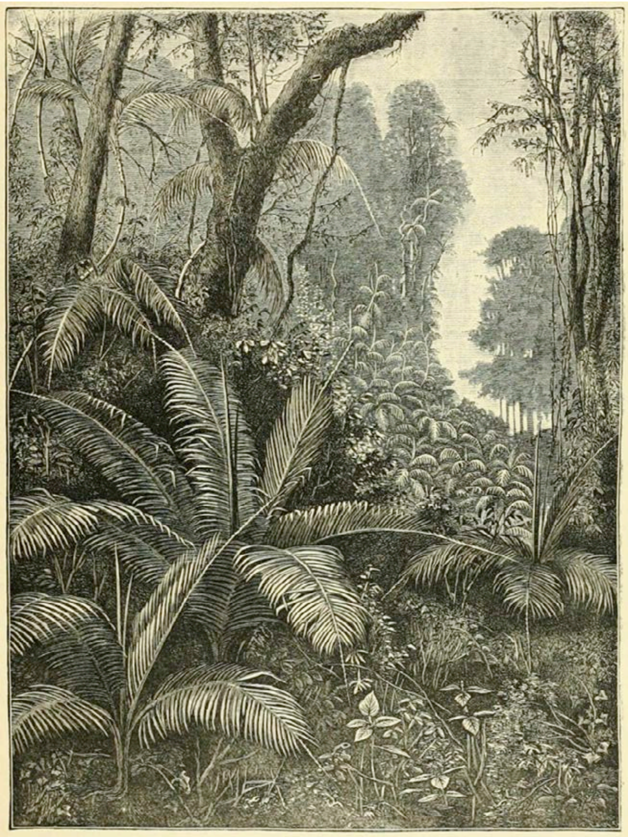

Fig. 94.—Indian Climbing Palms (*Rotang*). From a photograph.

Fig. 2.3. *Indian Climbing Palms (Rotang), 'From a photograph'*, from Kerner 1895. Vol.1: Fig. 94.

This kind of illustration was poorly suited to the communication of a visual plant physiognomy, which would require attention to the appearances of particular stands of vegetation, in specific locations. Whether Kerner was aware of this difficulty in his pictorial strategy is uncertain. But it would be unsurprising if he accepted these conventionalised illustrations at face value; they were, after all, the only kind available. It does not seem to have occurred to him to use photographs extensively and, even where his images were taken 'from photographs' they were governed by similar pictorial conventions of picturesque landscape and the botanist's emphasis on the specimen.

Ecological Foundations: Eugenius Warming and Andreas Schimper

Kerner's *Pflanzenleben* was the first serious attempt to bring contemporary botanical research together with 19th century developments in phytogeography. But in many ways, Kerner's two-volume work was a standard botanical textbook, proceeding from physiological and morphological perspectives. Few studies had been attempted, at that date, into the actual responses of plant-life to environmental factors, or into the resulting distribution of plants and plant communities. Consequently, Kerner's treatment could do little more than overlay a poorly developed physiognomic classification of vegetation onto the observations of floristic botany. Within three years of the English publication of *Pflanzenleben*, two new texts had been published which would ultimately transform the study of ecological botany in Europe and North America. In 1895 — the same year Kerner's *Pflanzenleben* appeared in English translation — Danish botanist Eugenius Warming (1841-1924) published *Plantesamfund: Grundtræk af den økologiske Plantegeografi.* Based on his lectures in plant geography at the University of Copenhagen, the book was quickly translated into German, in which language a few British botanists encountered what soon became recognised as the founding text for self-conscious ecology. The second text, published in 1898, was Andreas Schimper's (1856-1901) *Pflanzengeographie auf physiologischer Grundlage* (*Oecology of Plants* in its English translation).[40] Schimper's book followed Warming in its consideration of ecological factors, but provided a more ambitious global account of phytogeography, attempting to apply Warming's oecological approach to all known vegetation types. For a visual history of early ecology, Schimper's book is the more interesting of these two foundational works, since it clearly follows Kerner in its pictorial strategy, whilst also

[40] Schimper 1898, first published in English translation in 1903, as *Plant-geography upon a physiological basis.*

promoting a much more wide-ranging use of photographic illustration in an ecological text. Although his illustrative approach was less well developed, however, Warming's ecological plant geography was no less visual.[41]

Illustration notwithstanding, the English translation of *Oecology of Plants*, also refined Humboldt's visual conception of phytogeography, in particular by giving an account of the related concepts of 'formation' and 'association' to describe units of vegetation. Warming was keen to place Humboldt's insights regarding vegetation on a more scientific footing, "for the physiognomy of vegetation is not only of aesthetic, but also of scientific significance." Vegetation determines the physiognomy of landscape, he wrote, and must therefore be scientifically considered.[42] In his general account of the 'physiognomy of vegetation', therefore, he sought to extend Humboldt's conceptual framework for vegetation, and to ground it in the physiological responses of plants to their environment. Even so, his scheme for discriminating broad vegetation classes ("forest, bush, meadow, moor, heath, steppe, savannnah, maqui, and so forth") relied upon visually qualitative divisions – an essentially visual taxonomy. These broad classes of vegetation could be discerned, he said, by assessing a range of characteristics or 'circumstances', as Warming called them. They included scientific parameters, such as 'seasonal relationships', 'duration of life', and 'number of species'. But these he listed only after a range of other, visually dependent characteristics, including dominant growth-forms, the density, height and colour of the vegetation, and even the colour of the soil.[43]

On the distinguishing features of vegetation, Warming had most to say about 'the number of species' but, like Humboldt and Kerner, he was primarily concerned with how those species were grouped in consistent associations, once again rejecting the dominant floristic botany as

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[41] The early publication history of Warming's book is instructive. Its first two German editions, in 1896 and 1902, and an English edition of 1909, contained no illustrations of any kind. In 1914, the Berlin publishing house responsible for the 1902 edition issued a new edition, which was illustrated throughout and included numerous photographs, several attributed to Warming himself. The text was also modified to incorporate development in ecology since the earlier editions. The preface for the 1914 edition was explicit in stating that the publisher had succumbed to the popular appeal of illustrations, referring specifically to Schimper's richly illustrated 1898 volume for comparison. The motivation for copious illustration in works of this kind was clearly as much a matter of commercial and popular interest as of scientific content.

[42] Warming 1909: 137. A further connection, made by practising naturalists, between their science and visual sensibility, and the continuity of visual and aesthetic appreciation of vegetation in a landscape, is underlined here by Warming's footnoted quotation from Charles Darwin: "A traveller should be a botanist, for in all views, plants form the chief embellishment."

[43] Ibid.: 137 *et seq.*

the basis for phytogeography. So central was this distinction for Warming that he opened his introduction with contrasting definitions of floristic plant-geography and 'oceological' plant-geography, the subject of his book.[44] After Warming, this distinction between a floristic account of vegetation, based on botanical taxonomy, and a vegetation classification based on physiognomy and species-composition or phytosociology, became the defining scientific distinction for ecology.[45] To draw back the description of massed vegetation in this way, from the abstractions of taxonomy to a concrete visual physiognomy, should be seen as part of a broader ecological project to reinvest plant biology with the empirical evidence of the senses, evidence obtained by direct experience in the field. In this context, a critical examination of the visual strategy evident in Andreas Schimper's *Pflanzengeographie auf Physiologischer Grundlage* casts a very different light on ecology's second foundational text which was the first to incorporate substantial numbers of photographs into a botanical or ecological work.

Both Eugenius Warming and Andreas Schimper were physiologically trained botanists who distinguished themselves from their teachers by recognising the importance of applying physiological insights to plants growing in natural conditions — that is, to the question of ecological adaptation. Schimper undertook little in the way of experimental fieldwork but made many ecological observations, based on extensive travels in tropical regions. *Pflanzengeographie* was the first academic book on ecology to be substantially illustrated with photographs. The first few chapters of the book were given over to discussions of the physiological factors affecting plant growth and adaptation. In these sections, photographs are scarce and the illustrations follow the conventions of botanical line drawings for describing plant morphology. Schimper's innovation here, derived from Warming, was to apply these illustration techniques to the environmental relations of plants, rather than to typical species morphology. The remainder of the book dealt with the description and classification of

[44] Ibid.: 1-2

[45] The distinction is perhaps best illustrated by a simple example. Consider pine trees and oak trees, both of which form the dominant species within distinct but related types of woodland or forest and, together with a range of associated species, give the vegetation its distinctive character. In taxonomic terms, however, an oak tree is much more closely related to heather (a dwarf shrub) or orchids than to coniferous trees. Such taxonomic relationships were of little use in describing the relationships between species that grew together in the same vegetation.

vegetation in the various climatic regions of the Earth and incorporated a great many photographs, taken from a wide range of sources. Schimper's book was quickly recognised by ecologists as "at once important as a contribution to science, encyclopaedic as a record of what was known, and fascinating as an unrivalled picture-book of vegetation."[46]

In a number of ways, Schimper's illustrative approach was similar to that of Anton Kerner's book. In particular, whilst the illustrations are more often photographic, Schimper's pictures resemble those of the explorer botanist, rather than the vegetation physiognomist. Like Kerner's illustrations, most often they foreground particular species of interest, reflecting the representational practices of floristic botany not the concerns of ecology. Many of the images were in fact provided by fellow (non-ecological) botanist-explorers. Not all were photographic but, in keeping with the age, many botanists had begun to prize the 'objective' gaze of the camera image. Where photographs were unavailable, Schimper used etchings and woodcuts from well-known botanical illustrators. One example, attributed to 'Martius',[47] and depicting 'virgin forest' in Brazil carries an additional annotation, 'somewhat diagrammatic', suggesting Schimper's anxiety about the uncertain authority of a non-photographic picture. In fact, many of the photographs used by Schimper might be characterised in the same uncertain way, their notional information-content overwhelmed by aesthetic intent. In a typical example, an unattributed photograph (Fig. 2.4 overleaf) shows trees around a marine lagoon in Singapore, its carefully structured image balancing the frondose growth-forms of coconut and nipa palms, against their own reflections in a smooth-surfaced lagoon. This could hardly be closer in composition (albeit reversed) and aesthetic effect to Kerner's woodcut depiction of tropical vegetation in India (see Fig. 2.3). Such pictures, supplied by other travellers, are common in Schimper's book. Mostly they comprise general 'views', containing little clear description of particular vegetation types, and yielding only a generalised 'formation', based on the physiognomy of the most prominent species.

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[46] Blackman and Tansley 1905: 199.

[47] Carl Friedrich Philipp von Martius (1794-1868) was a German academic botanist and explorer who travelled widely in Brazil during 1817-1820 and, with the assistance of many other botanists, published the huge *Flora Brasiliensis,* in 15 volumes and over 10,000 pages.

FIG. 226. Cocos nucifera, Nipa fruticans, Hibiscus tiliaceus (to the right) on a marine lagoon at Singapore. From a photograph.

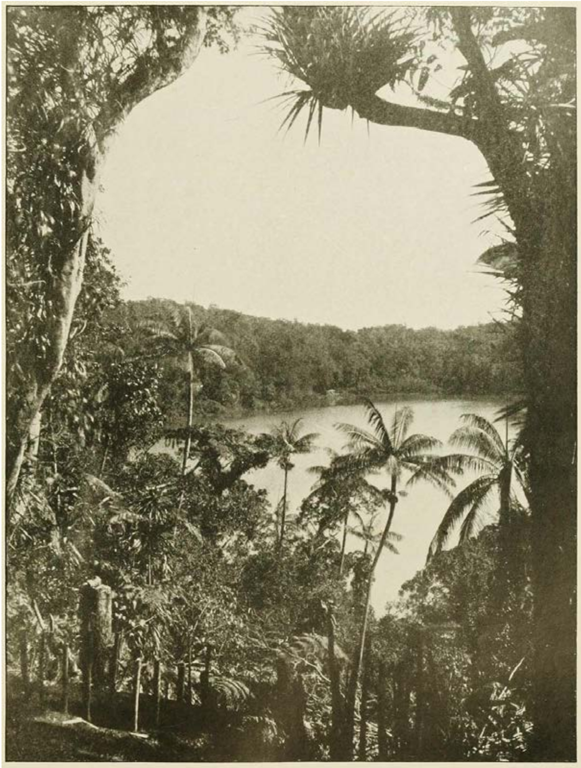

FIG. 130. Recently thinned part of a forest in the interior of Samoa, 300 meters above sea level. Palms. On the branch to the right, an epiphyte, Astelia sp., in flower. In the background the intact rain-forest. From a photograph.

Fig. 2.4. Schimper 1903. Figure 226. *Marine lagoon, Singapore;* Figure 130. *Montane rain-forest, Samoa.*

The appropriation and re-inscription of images, often made for non-scientific purposes, into the new context of a work on vegetation ecology appears innocuous enough at first sight and a reasonable aesthetic strategy for commercial publication success. Unfortunately, such recoding is rarely complete. Where conventional readings of re-purposed images do not stand in conflict with their new contexts of meaning, re-inscription remains unproblematic. When an image carries the marked cultural or epistemological echoes of its primary context, however, a kind of semantic dissonance may result and the limits of photographic recodability may become strained.[48] The photographs in Schimper's book were intended to support a scientific account of the world's vegetation. However, far from providing the clear descriptive values required for such a purpose, most of the pictures reflect a 19th century popular preoccupation with exotic climates and landscapes, frontier territories and views of a picturesque character.[49] This picturesque outlook was on display almost wherever Schimper took his

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[48] See Edwards 2001 Edwards 2001: 5 *et pass.* and Edwards and Hart 2004 Edwards and Hart 2004: 5 on the recoding of photographic meaning.

[49] See Nancy Stepan, *Picturing Tropical Nature* (2001) for an account of the ubiquitous popular appeal of such imagery which, as Stepan says, reflected a cliché of tropical romanticism, a commonplace of the 19th century European pictorial imagination of exotic equatorial regions.

overview of the world's vegetation, from the tropical rainforests of Brazil or Java, to the high forest of the Sierra Nevada. Such photographs are not asked to do much work, scientifically speaking. As botanical photographs, they lack sufficient detail to illustrate any but the grossest morphological characteristics, and almost always reflect the interest of the botanical collector in one or two prominent or notable species. For ecological purposes, they provide inadequate information on vegetation structure or composition. In the absence of this information, they are constrained to an aesthetic response to exotic landscape and location. Clearly Schimper regarded this recruitment of pictorial values as unproblematic, even within a text that aspired to comprehensive scientific objectivity. He appears to have been unaware or unconcerned by the possibility for epistemological ambivalence in representing vegetation through notable species and conventional landscape views.

The sources from which Schimper borrowed his illustrations simultaneously determined their aesthetic character, and constrained their scientific content. The point is accentuated in the pictures Schimper borrowed from practising ecologists. In describing the vegetation of xerophytic habitats, for example, Schimper incorporated a number of photographs from the studies of American ecologist Henry Cowles, in sand-dune systems near Chicago, and photographs from various ecological studies in New Zealand by Leonard Cockayne. In contrast to the picturesque images of botanist-explorers, these were prosaic landscapes, intended to allow close visual inspection for the confirmation of vegetation physiognomy, habitat conditions, on plant associations and species composition, with such details further described in captions or other supporting text. In a photograph taken from American ecologist Conway Macmillan's exhaustive study of the physical and botanical constitution of vegetation communities around the shores of Lake of the Woods, Minnesota in the 1890s, Schimper's annotated figure 98 with a number of species characteristic for Macmillan's *Salix mid-strand* formation (Fig. 2.5).[50] No such annotations were possible for pictures drawn from other sources, where detailed, site-specific data was not available, because the photographs were made with other purposes in mind.

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[50] Schimper 1903: 183; MacMillan 1897: Plate LXX. MacMillan's work at Lake of the Woods was subsequently recognised by German phytogeographer Oscar Drude (Drude 1906a) as the first significant ecological study in America.

FIG. 98. Shore of Garden Island, Lake of the Woods, Minnesota. Salix fluviatilis predominant. Besides this, Capnoides micranthum, Chenopodium album, Polygonum ramosissimum, and other plants. From a photograph by MacMillan.

Fig. 2.5. Schimper 1903. Fig. 98, from Conway Macmillan, 1897. *Salix mid-strand formation. Sandy deposits with mixed formations.*

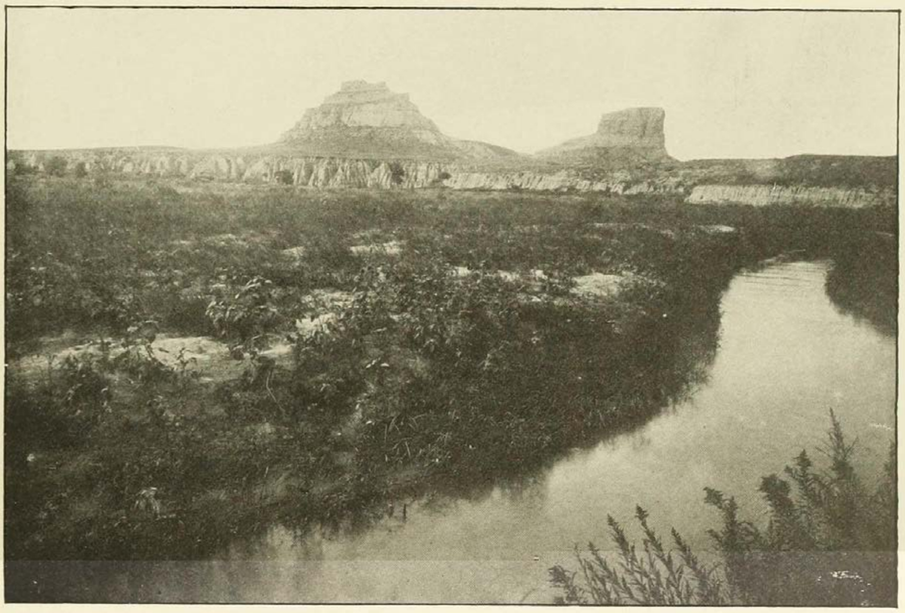

FIG. 96. Nebraska. Sandy deposits with open mixed formation of plants in a river-bed. In the background, grassland formation (prairie) corresponding to the climate, and bare rocks. Photograph from the Geological Department of Nebraska University.

Fig. 2.6. Schimper 1903. Fig. 96. Geological Department of Nebraska University, Undated.

In a section on edaphic vegetation formations, for example, Schimper used photographs supplied by the Geology Department of Nebraska University. These images carried no substantive information on plants or vegetation, even in their captions. In using photographs made for other purposes, Schimper limited their reference to simplified illustrations of general habitat conditions (Fig. 2.6)."[51] The aesthetic contrast between these images and those drawn from ecologists is also instructive. In its original setting, Macmillan's photograph of lake-shore vegetation was an emphatically 'straight' photograph which worked to communicate the key visual information required to recognise the vegetation communities present, together with important habitat variables, in this case a transition from aquatic to terrestrial conditions. Additional key information on community composition is indicated in the caption, with further details in the main text.[52] Nebraska's geologists had their own scientific purposes for the photograph that became Schimper's fig. 96 but their's is a much more self-consciously composed landscape view than Macmillan's lake-shore. Its gently reflective watercourse leads the eye to distant but dramatic rock formations, separated from the river by an undifferentiated prairie floodplain. The photograph is an example of what Robin Kelsey has called 'archive style', in which the strict documentation of survey photography is allied to aesthetic motivations for picture-making in the landscape.[53] Macmillan's shoreline provides a visual leading-line too, but here the lake shore merges with the background scrub as an extended horizon-line, beneath a 'carelessly' rendered sky. The geological photograph opens onto a 'view' but closes down interrogation of the habitat and its vegetation cover. The ecologist's photograph closes off the 'view' and encourages examination of the detailed texture of what is before the camera. The divergence of these images as carriers of scientific information is evident. They represent very different ways of perceiving the natural landscape. It is often possible, of course, to identify species, and even vegetation communities, from photographs made for other reasons, but examples such as these expose the limitations of photography's representational capacities and its insufficiency as evidence in the absence of interpretation and supporting information. In promoting the use of photographic illustration through such mixed imagery, Schimper's pictorial strategy draws attention to photography's limited competence as an evidential support for science.

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[51] Schimper 1903: 181.
[52] MacMillan 1897.
[53] Kelsey 2007.

Like Kerner and Warming, Schimper followed Humboldt in presenting a physiognomic approach to vegetation. Kerner's illustrated text reflected Humboldt's generalised amalgam of aesthetics and science. In *Pflanzengeographie*, Schimper presented a 'picture-book of vegetation' which was more comprehensive and more detailed, and more conflicted, than Humboldt's amalgamated vision. Reflecting the increasing separation of late 19th century science from art, both Warming and Schimper were keen to impress upon their readers the scientific nature of vegetation study. At the same time, Schimper shared with his readers a fascination with representations of the exotic and the picturesque. The resulting pictorial strategy is contradictory. Driven as much by popular appeal as scientific endeavour, the images are illustrative and analytical by turns, sometimes aesthetic, sometimes floristic, and occasionally ecological. The resulting visual contradictions are important for understanding photographic practice in ecology as it emerged into the 20th century. I will explore the central pictorial contradiction between floristic and ecological approaches to botany in in subsequent chapters. For now, it is sufficient to note its presence at the core of an uncritical pictorial strategy in one of ecology's founding texts.

Mapping the field: the beginnings of British vegetation survey

The phytogeography of Humboldt and his successors gave rise to generalised schemes for describing vegetation as a distinct object of study. However, whilst Kerner provided information on the species-composition of a few vegetation formations in *Das Pflanzenleben der Donaulander*, his formations were not assigned to precise locations. Neither Warming nor Schimper provided clear accounts of the vegetation of particular localities.[54] In the late 1890s, however, a young Scottish student by the name of Robert Smith (1873-1900) sparked British ecology into life, in a shift away from these generalised descriptions, by paying close attention instead to the constitution of particular landscapes, particular kinds of vegetation cover and their constituent species. It is part of my purpose in this thesis to show that changing practices of visual representation in phytogeography mark a disciplinary transition between 19th century botany and 20th century ecology. That transition was both graphical and epistemological; from hand-drawing to photographic representation; from botany with the

[54] Warming did finally publish detailed studies of vegetation along the Danish coast, but not until 1906, in *Dansk Plantevaekst* (Warming 1906). Following what by now had become standard for ecological publishing, the book was abundantly illustrated with photographs. It is worth noting that, like other ecologists, when he wished to describe the detailed physiognomy and composition of vegetation, Warming 'went home' to study the plant communities in the familiar landscapes on his doorstep.

construct of the species at its heart, to vegetation science, for which the proper unit of study was the plant-community or association. Ordinary and common species became the focus of attention in the new vegetation science, which sought not only to describe their generalised geographical distribution, but to account for apparently consistent associations between common species, and for their physiological adaptations to environmental influences, in identifiable places. This profound shift, from the taxonomic to the ecological, and from the generalised to the particular, marked the birth of ecology as a science of complexity and relatedness. It is doubtful whether there is ever an identifiable point of transformation for such epistemological change, but the broad transition I wish to describe is most clearly discernible in the changing visual strategies adopted by phytogeographers for representing vegetation. Changing representations may themselves bring about epistemological transformation and, as the 19th century ended, a new generation of plant ecologists found new ways to train their eyes on vegetation as a complex but unified biological object,[55] using new survey methods and new visual strategies for recognising and representing plant communities, in which photographic and cartographic methods took centre-stage. I will return in detail to the mapping practices of ecologists in chapter 5, in a discussion of the visual methods of early ecology. In this section, I want to show how the entwined practices of mapping and photography contributed to the emergence of the first ecological vegetation surveys, whilst also acknowledging the methodological and theoretical debts that these surveyors owed to 19th century botanical geographers from Humboldt onwards.

The first such surveys in Britain were undertaken in Scotland by a young botany graduate, Robert Smith.[56] Smith had taken up botany and zoology at his local university in Dundee in 1893, under Professors Patrick Geddes and D'Arcy Thompson respectively. In 1896, he became a postgraduate demonstrator in botany under Geddes, from which position he obtained a research scholarship to study under Charles Flahault (1852-1935) at the University of Montpelier in France.[57] Flahault was a beneficiary of the Humboldtian legacy in vegetation

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[55] The ambiguity of the word 'train' is useful here denoting a 'turning of the gaze' towards their new object of study, but also 'teaching how to see' vegetation in ecological ways.

[56] A similar shift is also discernible in the early history of American ecological methods. In 1895, Frederic Clements and Roscoe Pound began innovative studies of the vegetation of the Nebraska prairies, which included the quantitative assessment of species within identifiable communities, at particular localities. This work, and that of Robert Smith, were undertaken independently of one another, but both can rightly be said to have initiated a transformation in the ecological description of vegetation in their respective continents (Pound and Clements 1900; Smith 1900a). Their influence was quickly drawn together in the subsequent work of British vegetation ecologists.

[57] Thompson 1901.

science. He followed Kerner and Warming in their general concept of plant communities, but he was innovative in his application of that concept to locally defined areas of vegetation survey, producing maps of vegetation types over specific, identifiable landscapes.[58] According to Robert Smith, Flahault's skill in such vegetation mapping was exceptional. "Those who have had the good fortune to accompany him in the field know the singular and almost instinctive faculty which Professor Flahault has of seizing, as it were at a glance, such essential features of the vegetation."[59] Unlike Humboldt and Schimper, however, Flahault was not attempting to reveal global patterns of vegetation distribution. He was concerned with the detailed configuration of plant communities at a local scale. In 19th and 20th century France, however, the landscape was heavily modified by human activities (principally agricultural), which had removed or transformed pretty well all original vegetation cover. Flahault's response to this difficulty was to use the floristic and habitat data gathered in his survey to reconstruct a series of 'natural' categories of vegetation which would have been expressed in a range of altitudinal zones, in the absence of anthropogenic modifications. The resulting vegetation-mapping was based, therefore, on a series of pre-determined, altitudinal classes and vegetation communities. Different vegetation types were classified according to their dominant growth-form, reflecting the Humboldtian physiognomic tradition. Working in the temperate climate of France, the resulting categories were inevitably based on the dominant trees of different forest associations.[60]

When Robert Smith came to apply Flahault's techniques, in Scotland, he quickly found this idealised reconstruction to be impossible in a landscape which was so profoundly altered with regard to its vegetation. As Smith put it, "The process of disforesting [*sic*] has proceeded so far in this country, that little primitive forest remains." He made an attempt to salvage something of his former mentor's methods, by making observations that would offer at least some comparisons between the two datasets. In order to draw comparisons with Flahault's tree-based mapping, he said, "careful record is being made of all evidence necessary for the determination of the areas which would be covered by the social trees indigenous to Scotland,

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[58] The term 'local' here should not be taken to imply a limited or parochial view of survey. On the contrary, Flahault's ambitions extended to a total survey of the vegetation of France. In this respect, the ambition of Flahault's mapping project should be seen as part of the broader late 19th century impetus towards a 'total cartography' which encompassed topographic surveys, geological surveys, vegetation surveys and any number of other mappable subjects.

[59] Smith 1900a: 387.

[60] Flahault 1897; Smith 1899; Mather 1999.

were these allowed to distribute themselves naturally without hindrance from man…from historical documents, place-names, and tradition, …from the examination of the contents of peat and other recent deposits, and from the study of the present vegetation, and of the climatic and soil conditions."[61] Following Warming, Smith made a clear distinction between floristic plant geography and ecological plant geography. "The vegetation of any region," wrote Smith, "is to be considered then as an association of plants bound together by the fact that they are all adapted to life in this region." And again, "The study of the vegetation has thus become a study of plant associations - the life-forms which constitute them, the conditions which determine them, and the relations between them."[62] This restatement of Warming's ecological principles places Smith clearly in the Humboldtian tradition of vegetation science. In practice, however, Smith's vegetation classification took a step away from Humboldtian idealism, towards a pragmatic naturalism. His classification and mapping of vegetation types was based on what he actually recorded at each survey 'station', not on a largely untestable hypothesis about the primordial vegetation assumed to have occupied the same station prior to human intervention. Instead of Flahault's idealised precursor vegetation categories, Smith's vegetation types received more detailed floristic treatments, based on field survey-data, emphasising the dominant species and their constant associates as diagnostic for distinct, mappable plant communities.[63]

For Flahault, and for the Smith brothers, the generalisations of Humboldtian vegetation science were unhelpful in understanding small-scale vegetation patterns and the appearance of vegetation at a local landscape scale. Addressing the British Association for the Advancement of Science in Glasgow in 1901, on the subject of his brother's Scottish surveys, William Smith pointed out that the vegetation accounts of Humboldt, Schimper and others

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[61] Smith 1900a: 388

[62] Smith 1899: 110.

[63] An exception was Smith's treatment of agricultural land, which he assigned to one of two broad classes - lowlands capable of supporting wheat cultivation, and uplands capable of sustaining oat crops. These were clearly artificial categories - but based on a combination of field observations, agricultural records and anecdotal reports from local farmers - and represented the supposed limits of profitable arable cultivation, rather than actual vegetation cover of particular plant communities. Smith's approach, which focussed attention on natural and semi-natural vegetation, paid little attention to the vegetation of farmland - which included not only arable crops annually harvested and ploughed, but much pasture grassland, hay meadows, hedgerows, treelines, ponds and watercourses - all of which would receive considerably more attention today, both from vegetation scientists and from conservationists.

had assumed "that the relations between vegetation and the factors regulating the distribution of plants, are so broad and general that they can only be represented on maps which include some large portion of the earth's surface drawn to a small scale."[64] It was not enough, he said, to take a few visual samples of vegetation growth-forms and generate an overriding classification grounded on 'vegetable physiognomy.' Phytogeography should pay attention to how species were *actually* associated in groups or communities, based on the accumulation of detailed species data, in actual vegetation units, over an extensive topographical area. Only once such data had been collected, and subjected to appropriate comparison, would it be possible reliably to define characteristic associations and map their geographical distribution. The Smiths' project sought to take a new step towards the objective, scientific description of vegetation. It might therefore be expected to eschew the more subjective and generic visual representations of previous phytogeographers. And this is certainly the case. The generalised pictorial strategies of Kerner and Schimper were of little use in understanding or describing the vegetation of a particular site. Nevertheless, in their efforts to reify vegetation types into perceptible objects, they were no less convinced of the value of visual description. Robert Smith's Scottish surveys were cut short by his untimely death in 1900, at the age of only 26. After Robert's death, his brother William Gardner Smith (1866-1928) completed the Scottish work for the districts of Edinburgh, Perthshire, Forfar and Fife. At the same time, he began new surveys in Yorkshire, where he had taken a lectureship at the Yorkshire College (subsequently the University of Leeds) in 1897[65].

In all cases, the reports of these surveys included detailed vegetation descriptions for particular locations, supported by photographs and species lists from "characteristic stations of different types".[66] Published in several stages, the work first instalment was published in 1903, covering 1700 square miles of the West Riding.[67] Fig. 2.7 shows typical pages from one of these surveys, in this case from Yorkshire. The papers were published together with coloured maps, showing the distribution of the vegetation types recorded. This tripartite

[64] Smith 1902: 133.
[65] Like his younger brother, William had studied botany and zoology at Dundee, with Geddes and Thompson.
[66] Baker 1903: 223.
[67] Smith and Rankin 1903.

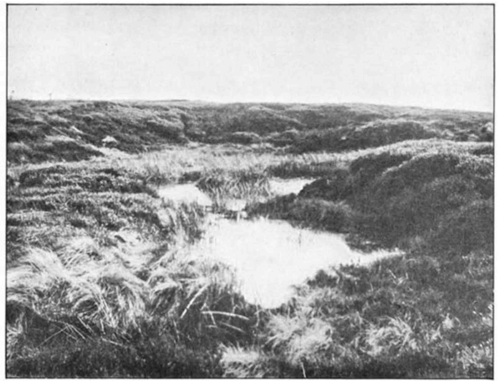

FIG. 1. On a Cotton-grass moor. The bog-tarn rests on clay at the base of the peat; the banks show the depth of peat. The background is the drier moor on deep peat.

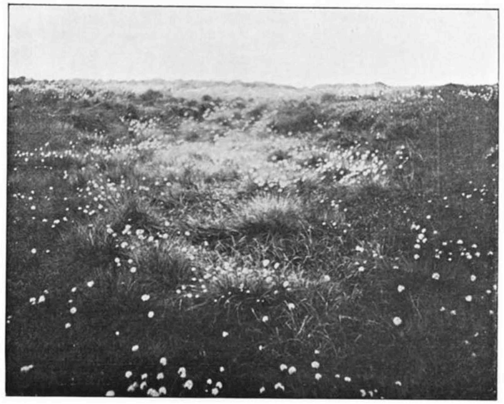

FIG. 2. Moss moor in June. Cotton-grass in fruit.

GEOGRAPHICAL DISTRIBUTION OF VEGETATION IN YORKSHIRE. 381

of England" itself. The cotton-grass flourishes best on the almost flat moor summit, where the rainfall is great, the drainage bad, and the peat thick and permanently wet or damp (Fig. 1).* These moors are locally known as "mosses;" and the vegetation of the area is extremely scanty in number of species. A few mosses and liverworts lie on the bare peat, a few species of algæ and lichens are not uncommon, now and then small fungi are seen, ferns are practically absent, and clubmosses are but rarely met with. The following are the flowering plants found in extreme cases of this Eriophorum association :—

†*Eriophorum vaginatum*, L. Usually dominant.
E. angustifolium, Roth. Sometimes dominant.
Empetrum nigrum, L. Occasionally dominant.
Rubus Chamæmorus, L. Sometimes abundant.
Vaccinium Myrtillus, L. Sometimes abundant.
Calluna Erica, DC. Not abundant.
Erica Tetralix, L. Not abundant.
Carex curta, Good. Infrequent.
Drosera rotundifolia, L. Rare.
Narthecium Ossifragum, Huds. Rare.
Lycopodium spp. Very rare.
Selaginella selaginoides, Gray. Very rare.

Such tracts are usually most monotonous in appearance. In autumn and winter, the reddish-brown leaves of the cotton-grass present a dreary aspect. Some life is infused into the area in early spring, when the dull florets make their appearance. In early summer the masses of white fruits form snow-like patches visible from a considerable distance (Fig. 2). The Eriophorum association is not extensively developed in Perthshire or Midlothian (1900), though R. Smith's unpublished maps show it to be of great extent in the west of Scotland. It is thus an association typical of the western region of Britain, and it seems probable that the association does not reach its maximum development with a rainfall of less than 40 inches (100 cms.). The recording stations of the Halifax waterworks, situated in the Eriophorum area, indicate a mean annual rainfall of nearly 45 inches.

The Eriophorum moor is an example of the association known to German botanists as "Heidemoor" or "Moosmoor," and may be indicated by the English term "moss" or moss moor. The *Sphagnum*, or bog-moss, is regarded as an important element in the formation of the deep peat always found on the moss moor; yet in our area, while the peat is from 5 to 30 feet deep, *Sphagnum* beds are by no means conspicuous. The general impression received is that the peat is being gradually denuded or wasted; and this agrees with the conditions found in the neighbouring Kinderscout district of Derbyshire, as described by Sir E. Fry (1892).

On the bleak ridges of the upper moors the bilberry (*Vaccinium*

* The photographs for this paper were taken by Mr. W. B. Crump, M.A. (Halifax), who has generously placed them at our disposal.

† The nomenclature of the London Catalogue, 9th edit., is followed throughout.

No. IV.—APRIL, 1903.] 2 C

Fig.2.7. Pages from Smith and Moss, 1903. *Geographical Distribution of Vegetation in Yorkshire.*

representational strategy recalls the threefold evidence base for Humboldt's earlier physiognomic classification of vegetation and an equally firm reliance upon visual methods.

Although William still presented the method as experimental, the Yorkshire study implemented the same methods employed by his brother in Scotland. Firstly, vegetation communities were recognised by "traversing the selected area till its prominent associations are recognised...the limits of prominent associations are ascertained and recorded on the field-map on the spot."[68] In other words, the associations were mapped in the field, by eye, and later transposed to fair maps for publication in colour. The resulting map showed the geographical/topographical distribution of each of the associations recorded in the field, both in absolute terms and in relation to other types. The rational basis for mapping was reinforced by the authoritative and 'objective' cartographic voice of the British Ordnance Survey, which was used as a base both for field-maps and the published survey (Fig.2.8)[69]. Secondly, a definitive list of characteristic species, was recorded for each vegetation type identified in a given area of survey, together with observations on physical habitats or other environmental conditions. In the example reproduced at Fig. 2.7, the typical species-composition of 'Eriophorum moorland association' is described, with an indication of relative abundance for each of the species listed.[70]

The third strand of evidence in the Smiths' survey method was provided by photographs. Except for a short footnote, which credited photographs in the paper to one of his students, William Bunting Crump, William Smith said nothing whatever about the use of photography as part of the survey method. Nor is the use of photography discussed in any of his brother's earlier papers. Yet it was consistently applied as a recording method, utilised throughout the ecological vegetation survey movement as it developed in Britain and elsewhere. The photographs were tacitly included, therefore, to show typical views of the vegetation types, views which re-present the visual identification of vegetation associations in the field. The pictures were typical, not in the sense of Kerner's or Schimper's generalised views, but typical of the particular sites where the vegetation surveys took place. They were representative and yet clearly located at specific sites of scientific study and, together with the maps and species lists, provided a mutually reinforcing structure of observation and evidence.

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[68] Smith and Moss 1903: 378.
[69] See chapter 5 for a detailed discussion of the cartography of vegetation mapping.
[70] Smith and Moss 1903: 381.

Fig. 2.8. Smith and Moss, 1903. *Geographical Distribution of Vegetation in Yorkshire*

Like those of ecologists who contributed photographs to Schimper's celebrated work, the photographs deployed in these papers are straightforwardly descriptive. They offer similarly closed and apparently neutral views, emphasising close detail and corroboration for scientificsurvey data. This kind of image is made by an ecologist, to describe in detail what he has seen. A unique combination of data (species-composition, geology, soil type, water relations etc.) provides a guarantee for scientific objectivity in observation; the photograph in turn anchors the scientific data to a particular location, and corroborates the scientific witnessing of specific places where these recognisable vegetation communities were recorded. This witness is every bit as personal as it is scientific. The personal and professional (that is, *ethical*) identity of the ecological scientist is bound up in this relationship to the particular locations where ecological work is undertaken.[71] The apparent aesthetic blankness of the ecological photograph is in fact an aesthetic *distance* that indicates this relationship; it is at once scientifically instrumental and subjectively expressive for a personal witnessing of place.

Also evident here is the effective effacement of visuality from the account, both of the survey methods employed, and of the resulting vegetation associations identified and mapped. Smith's account presented the visual aspects of the survey as unproblematic, straightforward operations for identifying, mapping and photographing the associations recognised. He foregrounded species data and environmental information as the most important kinds of evidence the method had to offer, and provided photographs as though they were self-explanatory. The photograph here is not an illustration, it is a transparent view to a real example of the vegetation association described in the text and in the data. Captions, and additional details within the text, refer to the images in just the same way an ecologist-observer might discuss what can be seen whilst in the field. As a consequence, the importance of the photographs as evidence is overlooked and, in this visual ellipsis, what is lost is an awareness of the photograph as a deliberately framed view, in which the prior question of *how* to look has already been settled. For the identification of vegetation associations in a photograph, a selection has already been made; where to point the camera, what to include and what to leave out. The annexing of the image to a verbal caption and other data completes the ellipsis and renders the photograph itself invisible. As Michael Dettelbach remarked in relation to Humboldt's isolinear drawings, it is as if nature were "tracing its own

[71] See Daston and Galison 2007: 198 *et seq* on the history of the 'scientific self'.

shape".[72] In fact, as we will see in the following chapters, photographs like these provided key elements in the evidential and rhetorical strategies developed by Robert Smith in Scotland and applied by ecologists in Britain and elsewhere over the coming decades.

[72] Dettelbach 1999: 487.

3. Expanding the Field: Making Associations

The principle of association is the fundamental law of vegetation.[1]

Most professional British botanists at the start of the 20th century fell within one of two broad but overlapping camps. One, the so-called 'New Botany', was in the ascendency, but the 19th century tradition of geographical and floristic botany was also still prominent. Both camps were systematists, concerned with the origins and proper taxonomic arrangement of the forms and varieties of organisms. Since the 1870s, however, British academic botany had been reorganised under the influence of the well organised system of botany then being taught in German Universities. Most of the 'new botany's' proponents had spent at least some time training in German laboratories and brought home new techniques for the study of plant morphology and physiology. They had achieved considerable success; their laboratory outlook and methods, and their emphasis on morphological studies in particular, had come to dominate the University curriculum. Floristic botany, with its institutional infrastructure centred on Kew and the British Museum, was the dominant approach of the 19th century. It was the governing model for Imperial botany, as well as for the great bulk of amateur practice. Its scientific direction was taxonomic and geographical, concerned with the enumeration and distribution of different taxa, strongly inflected at a global level by colonialist economic imperatives.[2]

Although ecologists in Britain had begun with vegetation survey, their ambitions for their new subject went much further. Their fullest intention was to redraw botany, in both its major aspects, as a science of the total environment. Their aim was to understand the dynamic processes of environmental and biological interaction at every level of organisation, from the individual organism to the global distribution of plant formations. From the outset, leading

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[1] Clements 1904.

[2] For a detailed recent account of the history and philosophy of natural classification, see Wilkins and Ebach 2014. For more on the 'new biology', and a more nuanced picture of the diverse and complex state of late 19th century biology in German Universities in the 1870s and 1880s, see Cittadino 1990, Nyhart 1995; Cittadino 2009: 233 *et seq*. Studies relating to 19th century botany in an Imperial context are numerous. For a general history of biogeography, see Janet Browne (1983). The picture of economic botany is well developed by both Richard Drayton (Drayton 2000) and Lucille Brockway (2002), including accounts of the discovery and transfer of critically important economic species across the Imperial world. Beinart and Hughes (2007) present a broad view of the material and economic relationship between the natural world and Empire. On the taxonomic emphasis in 19th century botany, see Christophe Bonneuil (2002), and Jim Endersby (2008) on taxonomic relations, arithmetical geobotany and economic values.

ecologists were aware that such an ambitious project would require the engagement and support of other botanists, and that they must embrace the 'new botany', by taking its physiological insights out into the field, where ecology's natural interests lay. The effect would be to enhance the professional standing of ecology and to integrate the two major strands of botanical science. Ecologists, in effect, faced both ways with respect to the established traditions of botany. They craved the ascendent professional status of the laboratory biologist, but also wished to retain their commitment to the field practices of natural history and geographical botany. Vegetation survey was the first necessary step towards this new botanical outlook. In the opening years of the 20th century, therefore, William Smith and a small number of other professional British botanists embarked on a concerted, strategic effort to promote further vegetation study, and to develop new methodological and theoretical principles for ecology. They set about trying to convince their professional colleagues, and to garner the support of a more diffuse network of naturalists and botanists around Britain. Having taken early inspiration from the 19th century phytogeographers examined in the last chapter, especially the recent work of Charles Flahault in France, Eugene Warming in Denmark and both Oscar Drude and Andreas Schimper in Germany, they also began to reach out internationally, finding opportunities to share knowledge and experience, and to build a broader platform from which to promote their new direction. The purpose of this chapter is to register something of this early progress, to examine some of the promotional strategies by which early ecologists succeeded in developing a new self-conscious scientific community, and to mark out the contribution of visual practices in making ecology distinctive amongst its scientific peers.

I will examine the visual field methods of ecology in more detail in chapter 5. Here, I want to consider the early development of British ecology in its social, institutional and disciplinary contexts, drawing out some intersections with the visual practices of field sciences more generally. Charting this history will make explicit the reliance of ecologists on the existing social and disciplinary practices of broader scientific communities, both professional and amateur. On the whole, ecologists were not especially innovative in these respects. The progress of ecology in the first decades of the 20th century confirms the civic and social character of Victorian and Edwardian science in general. Ecologists associated through similar social networks, attended the same kinds of meetings, conferences and social events as any of their scientific contemporaries. They made use of the same widespread technologies of record, communication and representation, building photographic collections, and exchanging knowledge through visual display and print publication. They were decidedly energetic in these activities, however, and succeeded in forging a new scientific community, by building on familiar social and disciplinary practices from within the existing communities of botanical science and natural history to which they already belonged. Beginning as a small number of independent workers, within little more than a decade, the new ecologists had constructed a modest institutional framework to nurture their fledgling discipline and made lasting links with similarly developing communities on an international stage.

British associations: Ecology at the BAAS

British ecology drew its first breaths of institutional and social life at the British Association for the Advancement of Science. Here, in the opening years of the 20th century, a few botanists began to regard themselves for the first time *as* ecologists and began to co-operate in presenting their ideas and efforts at the Association's annual meetings. Their ambition was to establish a national movement to survey and map vegetation, at the level of individual plant communities, to obtain a full picture of the character and distribution of different vegetation types across the whole of Britain. Realising this aspiration would require support. A great deal of fieldwork would be needed, necessitating the involvement of many more surveyors. To obtain that support, they would need first to convince botanists that the endeavour was worthwhile, and that they should re-direct their expertise away from the customary concerns of botanical inquiry. In 1901, the British Association seemed an attractive prospect for such a persuasive project. The BAAS had already been used in this way, to promote new directions for scientific inquiry and to encourage collaboration in large scale survey projects.[3] Through its Corresponding Societies, the Association also offered access to a large number of amateur field naturalists and botanists. Through these local networks, notionally at least, an extended workforce was ready to hand for undertaking survey work, under appropriate central direction. Around the turn of the 20th century, the desire for comprehensive and co-ordinated surveys of all kinds was especially strong. At the Glasgow meeting in 1901, for example, zoologist Edward Bles suggested a new committee under the

[3] Relatively recent examples had included a committee for Anthropemetric Measurements in the British Isles, which was appointed in 1875, and reported in 1883 (BAAS 1884: 253 *et seq*). Participants were offered guidance on making and recording features such as skin complexion, the colour of hair and eyes. A further committee was appointed in 1892 to coordinate an Ethnographical Survey of the United Kingdom, compiled a 12 page pamphlet to guide surveyors in the correct measurements (anthropometric and archaeological) and suitable questions regarding folk customs and antiquities (BAAS 1894: 621 *et seq*). Still earlier, a strong BAAS coordinating influence was put to work in meteorological surveys and in astronomy (Anderson 2005; Tucker 2005).

BAAS, to coordinate and regulate a standardised method for recording local faunas should, to be adopted by all local societies.[4] Similar calls for coordinated activity were also expressed outside the BAAS. In a Presidential Address to the Botanical Society of Edinburgh in 1903, for example, James Trail bemoaned the confused state of botanical data across Scotland and called for more systematic surveys, praising the vegetation work of the Smith brothers as one such approach.[5]

Amateur scientists shared their professional colleagues' aspirations, and their generalised conviction in the value of data collection.[6] Local societies were also keen that their efforts to gather such data should be regarded as contributing to the objectives and aspirations of the established scientific community. This sentiment was demonstrated repeatedly at the Corresponding Members Conference of the BAAS after 1900, and was matched by a widely perceived need for comprehensive scientific surveys. Its clearest expression came from the Rev. J.O. Bevan at the 1901 Conference, who proposed that local societies should cooperate to undertake systematic surveys of every county, covering ethnology, ethnography, botany, meteorology, ornithology, archaeology, folklore, and anything else they could come up with.[7] The proposal was a popular one and was rewarded by the establishment of an impromptu committee, which reported back within 5 days with recommendations for subjects suitable for systematic survey effort, and contact names for those able to advise on appropriate methods. Proposals included a scheme for the registration of type specimens, records of bore holes, wells, and geological sections, surveys of underground waters, lakes and rivers, erratic blocks,

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[4] BAAS 1901: 683-685.

[5] Trail 1903.

[6] Perpetuating their long-standing enthusiasm for collecting specimens, amateur naturalists were especially keen on careful data collection. Mr Cosmo Johns, for example, a member of the Yorkshire Naturalists' Union, encouraged his fellow members to make accurate locational records on large scale maps for all their observations. A scientific observer, he said, should "look out for and note every fact relating to the particular research work that may be engaging his attention. All the more necessary is it, therefore, that the amateur worker, after going as far as he can, should leave his investigations in such a form that another worker might extend and complete it. Of late much useful work has and is being done by local societies in botanical survey, recording of erratic boulders, etc., and no effort should be spared in ensuring that this and other local work should be as complete and accurate as possible." (Johns 1905: 261)

[7] BAAS 1901: 472-5. Bevan identified a number of national schemes already underway or under consideration, singling out a proposed scheme for an Archaeological Survey of England and Wales, and the National Photographic Survey under Sir Benjamin Stone. Canon James Oliver Bevan, was a long-standing delegate to the BAAS Corresponding Societies Conference, having represented the Woolhope Naturalists' Field Club since 1890. He also served on the Corresponding Societies Committee. Bevan's own interests were broad; he was a Fellow of the Geological Society and of the Meteorological Society, and he published archaeological surveys for the county of Herefordshire, as well as works on religious and scientific education.

underground fauna, and collections of geological and botanical photographs, as well as comprehensive archaeological and botanical surveys for every county. Before the Association met the following year in Belfast, all the Societies had received an expanded list of subjects for co-operative work and committee contacts from relevant Sections of the Association. The list was wide-ranging and included a total of 18 different proposals from 7 of the 12 Sections of the Association, including Chemistry and Zoology, Geology and Geography, Engineering, Anthropology and Botany.[8] This was the immediate context into which William Smith stepped to present a paper to the 1901 Glasgow meeting, on the subject of a new kind of botanical survey. His proposal for a county by county botanical survey along similar lines was adopted by the Corresponding Societies as a strong candidate for action, under central expert advice from Smith himself. There was every reason to be optimistic about the prospects for launching the hoped-for national vegetation survey.

But Smith was proposing a new method of field study, new for botanists as well as for geographers, and he knew he had to work to do in convincing his colleagues to take up the new approach. In opening, he referred his audience optimistically to "an increased interest in the study of plants in relation to their environment or, as it is called, œcological botany,"[9] as if botanists everywhere were already adopting an ecological perspective. In fact, the number of botanists engaged in ecologically-oriented studies in 1901, whether in Europe or the United Sates, could be counted on the fingers of both hands, and those undertaking similar vegetation surveys on just one. Smith's observation was deliberately promotional, drawing legitimacy from a hypothetical scientific community, conjured out of a dispersed and negligibly small population of active ecological botanists.[10] The paper was, nevertheless, the first challenge to British botanists to take up the concept of the plant association and, along with it, the systematic survey of vegetation throughout Britain, as part of a new community of 'œcological botany'.[11]

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[8] BAAS 1903: 851-853

[9] Smith 1902: 133.

[10] My conscious reference here is to Benedict Anderson's idea of the 'imagined community' of dispersed members cohering around a shared conception or interest, commonly mediated through technologies of representation (Anderson 2006).

[11] Smith deliberately contrasted the new ecology with the presiding floristic methods for recording plant distribution in Britain, established by Hewett Cottrell Watson (1804-1881). All serious botanists would have been familiar with Watson's method and, valuable though this approach had been, Smith suggested, attention should now turn to the analysis of plant associations and the adaptation of species to their environment. "The association is ... a mixed community with complex relationships, its members struggling for existence and dominance, but it is a coherent whole, and may be studied as a unit" (Smith 1902: 134). A prolific botanical worker, Watson spent 50 years systematising the

Smith was unable to attend the BAAS meeting in 1902 but, when the Association met in Southport in 1903, he joined forces with a number of other ecologically minded botanists who were to become key players in the founding of a recognisable tradition of vegetation study in Britain. They included two of Smith's own students — William Munn Rankin and Charles Moss — together with academic botanists Otto V. Darbishire, and Francis J. Lewis — all speaking on various aspects of vegetation survey and ecology. Together they dominated the Geography section session for September 15th.[12] Rankin also spoke to the Corresponding Societies, advertising the vegetation survey work already underway by himself, Smith and others in Yorkshire as "the first instalment of a Botanical Survey of England and Wales."[13] A third of Smith's students, Thomas Woodhead, supported Rankin's efforts from the floor, declaring the new method "here to stay".[14] Woodhead also presented his own paper on *Methods of Mapping Plant Distribution*, to the Botany section of the main conference, on the 15th September, as Smith and others were speaking to the Geography section. This was a co-ordinated strategy to put the science of vegetation survey before key parts of the scientific community, promoting the new ecological botany on multiple fronts. At the next meeting of the Association, in Cambridge in August 1904, Smith and company were present in force again, this time in a full session of the Botany section. Proceedings were opened by Arthur Tansley, the senior British botanist of the session, and joined by the German botanist Adolf Engler, a geographical botanist of international status. Tansley's introduction, on *The Problems of Ecology*, provided British ecology with its first clear theoretical foundation and the first public statement of challenges and aspirations for a new science.[15] Papers on vegetation survey and other ecological studies dominated the remainder of the session. Tansley, who was at this time a botany lecturer at University College London (UCL), would soon become widely

geographical recording of British plants within a framework of geographical 'provinces' and 'vice-counties', in his *Cybele Britannica* and its supplements, between 1847 and 1874 (Watson 1847-59, Watson 1873-74). He edited the London Catalogue of British Plants from 1844-1874 and ran the London Botanical Exchange Club as a means of improving distributional data on British plants. The Club was the direct forebear of the current Botanical Society of the British Isles, whose journal is named *Watsonia*. The Watsonian Vice-County is still the accepted geographical unit for floristic botanical recording in the British Isles today. For an account of Watson's place in the history of British botany, see Allen 1986. For a fuller biography, see Egerton 2002.

[12] BAAS 1904: 725-727.

[13] Ibid.: 477.

[14] Ibid.: 480.

[15] BAAS 1905: 797. The paper was published in full in *New Phytologist* in October 1904 (Tansley 1904a). It is not clear whether Tansley had heard Smith's paper to the Geography section meeting in Glasgow in 1901 but he had taken up the cause of ecological phytogeography with enthusiasm, following the 1903 spate of publication by Smith and others.

recognised as the leading figure in British ecology. In 1902, he had already called for more ecological research. In particular, he had singled out vegetation surveying as one of the first important tasks for British ecology, and the need for coordinated effort by a large number of workers. Those workers, he thought, could be drawn from the members of local natural history societies, working under the central direction of a committee appointed by the BAAS.[16]

It is likely, however, that neither Tansley's suggestion, nor Smith's proposal to the BAAS in 1901, was well understood at first by other botanists. Despite its Humboldtian lineage, *vegetation* was by no means given as an object of study at the start of the 20th century. Any botanist could see the difference between forest, grassland or heath, and knew from experience that certain plants were more likely to be encountered in one kind of vegetation than another, but the grouped association of plants into consistent, identifiable plant communities was not such an obvious matter. For most botanists, the recognition of plant associations *per se* was wholly new. They were experts at finding, collecting and recording specimens, not plant associations. They had a fondness for rare species and varieties and, even when they collected common plants, they did not often pay close attention to other plants growing nearby, or to the wider habitat context from which their collections were made. The ecological approach was a challenge to these customary observational practices, forcing botanists to attend to the stand of vegetation in its entirety, to consider the relationships between plants and species not in systematic terms but in terms of *in situ* environmental relations.

In the face of such uncertainties, it was clear to both Smith and Tansley that promoting their new science of vegetation also meant communicating its basic concepts and its legitimacy as an object for scientific study. This would require not only verbal rhetoric, but a decisive shift in visual field methods and their associated representational practices. According to Tansley, vegetation survey was "comparatively easy and very attractive work" for amateur botanists. Good botanical knowledge, a basic understanding of geology and "quick eyes" were all that was required.[17] The challenge for ecologists was to train botanists' eyes to see in new ways. In fact, Tansley unwittingly identified the means by which this would be achieved, adding that "good maps and a camera are very desirable adjuncts" for vegetation survey work. When Tansley wrote this he had undertaken no practical field survey

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[16] Tansley 1902a: 85.
[17] Ibid.

of vegetation of his own, nor had he seen the work of the Smith brothers.[18] He did not yet know that these instruments would come to occupy a central place in the methods of vegetation survey adopted by British ecologists, and in their project to persuade others of the value and legitimacy of their work. In the following years, ecologists made plant associations real by mapping them and by photographing them. They sought to persuade others of the reality of vegetation communities by showing them maps and photographs, and by encouraging them out into the field to 'see' for themselves.

Collecting associations

From the outset, ecologists demonstrated a devotion to photographic presentation, both in print and in performance, at the BAAS and elsewhere. The visual elements of scientific discourse at the BAAS are difficult to discern clearly in the Association's annual reports, since they are largely confined to printed texts. Nevertheless, frequent references to objects and technologies of display indicate a highly visualised culture amongst natural scientists of every kind. Natural objects, artefacts, instruments, drawings, maps, diagrams, photographs and lantern slides were all in common use at the BAAS, just as they were at other kinds of scientific meeting throughout the 19th and early 20th centuries. In such contexts, as Jennifer Tucker has said, scientists both reflect and create visual culture, using visual representations to construct specialist knowledge and its institutional support. In presenting their work at such meetings, ecologists made full use of all these forms of visual argumentation, as evidence and illustration for the novel objects, ideas and practices of their science.[19] But ecologists can be marked off from their botanical colleagues by a particular devotion to photographic representation. This preference was especially evident, as we will see in the next chapter, in the print cultures of ecology, but it was also conspicuous in the performative discourses of scientific meetings. The work of all the British ecologists contributing to Tansley's session at the BAAS in 1904 was published elsewhere,[20] incorporating with the same prominent

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[18] Tansley 1947: 132

[19] Tucker 2006. Such displays should be seen also in the wider context of an established culture of scientific demonstration and popular performance. See for example, Alberti 2003; Tucker 2005; Morus 2006; Landecker 2006; Fyfe and Lightman 2007; Lightman 2007, 2012. It is important to see these kinds of visual display not simply as spectacle, however. Many scientists attempting to communicate their ideas and discoveries, whether to their scientific peers or to a wider public, employed visual presentations not as simple illustration but as *argument.* This is a point well made by Norton Wise 2006.

[20] Smith 1900a, 1900b; Smith and Moss 1903, Smith and Rankin 1903; Lewis 1904; Woodhead 1906; Moss 1907.

photographic illustrations featured in their presentations, alongside maps, sketches and supporting survey information. In 1904, in addition to the presentations of the numerous ecologists, and a display of photomicrographs showing freshwater algae, the session included an exhibition of Kammatograph pictures, demonstrating time-lapse photography to show the movements of plants.[21] In the same year, Richard Yapp spoke on the *Vegetation of the Fen District near Cambridge*, illustrated with lantern slides. He returned in 1906 with lantern slides of vegetation types from South Africa.[22] From Smith's first appearance at the BAAS in 1901, these photographic and other visual tools became part of the 'general exchange and flow' of ecological data.[23]

The ecologist's conviction in the persuasive and reifying power of photographic representation was particularly evident in schemes for collecting and exchanging photographs. The same impulse to make collections of photographs, both as scientific records and as institutional apparatus, was widely felt in a range of disciplinary communities.[24] Collections gave direct expression to a widespread assumption of the knowledge value inherent in comprehensive datasets and of the mechanical fidelity of photographic realism. But faith in the scientific evidence of photographs did not arise automatically out of the ontology of either science or photographs. Scientists sought consensus for their subject, and faith in its representations, through shared social and institutional infrastructures and shared scientific discourse. The BAAS provided an important stage for such public controversy and regulation in science and, in the 1880s and 1890s, a number of photographic collections were established under direct patronage from its various Sections.[25] These projects placed

[21] BAAS 1905: 802. Mrs. Drina Scott was the exhibitor. She took her kammatograph movies to numerous other audiences in succeeding months, including the Linnean Society and natural history societies (*Proc. Linn. Soc.* 1904 117: 10-11; Holmesdale NHC 1904: 73). The innovative German plant physiologist Wilhelm Pfeffer was the first to make time-lapse movies of plants, making four time-lapse films between 1898 and 1900. Lucien Bull, at the Institute Marey in Paris, had also produced moving time-lapse images of an opening flower (Gaycken 2012).

[22] BAAS 1905: 636; BAAS 1907: 758; *New Phyt*. 1906: 188; Weiss and Yapp 1906; Yapp 1908.

[23] I take this phrase from a similar observation made by Elizabeth Edwards in relation to the use of lantern slideshows in anthropological discourse (Edwards 2000).

[24] Jennifer Tucker (2006) points out the general growth of such scientific photographic collections from the middle of the 19th century onwards and the ontological faith in photography that underwrote them.

[25] Photographic collections were established for geology in 1889, for meteorology in 1890 and for anthropological photographs in 1898 (BAAS 1890: 191-2; BAAS 1891: 751; BAAS 1900: 592-3). Initiatives to make photographic collections at this time must also be seen in the context of a broader impulse to photographic recording, and as part of the more general desire for comprehensive and detailed survey to which I have already alluded. See Edwards 2012a for a history of the wider photographic survey movement in Britain, and its connections to the BAAS. For a fuller exploration of

photographic evidence at the centre of scientific practice, bringing the supposed veracity and objectivity of mechanical imaging to a range of disciplinary discourses, promoting visualised forms of knowledge exchange as well as further specialist study. When a Botanical Photographs Collection was proposed at the BAAS in 1901, therefore, ecologists were particularly active in its promotion and management.[26] From the very beginning, the collection became entwined with the ecological effort to promote vegetation surveys. Its subsequent development and demise underlined the epistemological difficulty facing ecologists seeking to transform the observational practices of their fellow botanists.

At its first appointment in 1901, the Botanical Photographs Committee recommended that its collection should be modelled on the schemes already in operation for geological and anthropological photographs.[27] The scheme offered little guidance to botanists on the kinds of photographs required, or how they should be obtained. In addition to their botanical knowledge, botanical photographers were expected already to possess the requisite photographic skills, or to seek detailed instruction elsewhere. The Committee issued some notes on appropriate photographic equipment, and on methods for the storage and registration of photographs. These were closely based on other schemes, with no particular consideration of botanical requirements. The Committee also followed the other surveys in offering advice for underwriting the scientific value of photographs, by ensuring sound recording of details as to photographic subject matter, including the name of the plant, the locality of the photograph, local rainfall figures, and any special features depicted, as well as the date, the name and address of the photographer and the storage location for the original negative. To ensure consistency in mounting and storage, prints were requested unmounted, the Committee undertaking to mount them all on a standard card.[28]

As things turned out, the botanical scheme was much less successful than its older siblings. In its last detailed report to the BAAS in 1907, the Committee's collection of botanical

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the 19th century relations of science and photography, see Jennifer Tucker's Nature Exposed (Tucker 2005). For a discussion of scientific photographic collections, see Wilder 2009: Ch.3, 79-101.

[26] BAAS 1901: 485.

[27] BAAS 1903: 471.

[28] BAAS 1904: 416-18. There is no evidence to indicate that the Committee's guidance was adhered to by contributors. In practice, few botanical photographers used whole-plates and many (including most ecologists) preferred the convenience of sheet film to heavy glass plates. For comparison, the guidance supplied for photographic surveys is reproduced by Elizabeth Edwards (2012a: 259 *et seq*). The Geological Photographs Committee guidance can be found in earlier BAAS reports (BAAS 1891: 429-432; BAAS 1893: 292-3; BAAS 1896: 406-7).

negatives and prints amounted to fewer than 350 photographs.[29] William Smith suggested in 1909 that the collection was "now fairly large",[30] but by 1911 the scheme had all but petered out and was wound up officially in 1913.[31] Despite its modest profile, however, the botanical photographs collection was important in the eyes of ecologists. The Committee began under the chairmanship of Yorkshire naturalist and educator Professor Louis Miall (1842-1921). Palaeobotanist and ecologist Frederick Weiss was also one of its founding members. From 1903, Weiss was joined by William Smith and Arthur Tansley. In 1906, the chair was taken by Professor Frank Oliver, friend and senior colleague to Weiss and Tansley at UCL. For the remainder of the Committee's short life, all its members were ecologists. Richard Yapp, formerly a lecturer in botany at Cambridge and now Professor of Botany at Aberystwyth, had joined in 1905, and Smith's Yorkshire colleague Thomas Woodhead in 1906, making a full complement of six.[32] All but Weiss were actively engaged in vegetation studies of one kind or another.

A large community of fieldworkers was a prerequisite for a comprehensive photographic collection, just as it was for a national vegetation survey. When Arthur Tansley first called for a national initiative for vegetation surveys, in 1902, he was clear that the work would need considerable "support from the local societies, whose co-operation would be essential to success."[33] The initiative was also clearly already linked in Tansley's mind with the methods and results already being achieved through other photographic surveys and their resulting collections. He alluded to the recently established Botanical Photographs Committee and suggested that the national vegetation survey might be achieved by extending that committee's remit, to coordinate the systematic work required for both kinds of recording. Significantly, he referred to the photographic collection scheme as *ecological*, rather than botanical. If the photographic scheme was to be of general appeal to ordinary amateur botanists, however, it must also answer to their primary interests and capabilities. The

[29] BAAS 1908: 417-421. The 1907 report included a second *List of Photographs of Botanical Interest* (the first does not appear in BAAS reports) which includes numbered entries up to no.347. By contrast, in 1901 the Geological Photographs Committee had registered and collected over 2,896 prints and negatives, the anthropologists had registered in the region of 2,000 pictures, rising to 4,000 by 1909. By 1910, the Geologists had registered 5,227 pictures, averaging contributions of 250 for each year since the scheme was launched in 1889. These estimates are drawn from the relevant BAAS reports from 1889 -1915. It should be understood that these figures relate to the number of pictures *registered* under these schemes not physical collections of photographs.
[30] Smith 1909: 205.
[31] BAAS 1914: 267.
[32] BAAS Annual reports 1901-1914.
[33] Tansley 1902: 85

Committee began, therefore, by accommodating the field interests of most amateur botanists, declaring that the collection should exclude photographs of histological preparations. The effect was to remove much laboratory work and a significant class of botanical photography practice, that of photo-microscopy. Instead, the terms for collection set out formally by the Committee at their 1902 meeting included "portraits of any species of plant (more particularly foreign plants, grown under natural conditions), illustrating habit, natural surroundings, or points of morphological or physiological interest." In addition, the collection would encompass "diseases and malformations of plants" and "photographs of plants raised for purposes of experiment." Finally, possibly under recommendation from Frederick Weiss, the Committee also included "photographs illustrating plant associations."[34]

This combination reflected the full breadth of interests among botanists, both professional and amateur, taxonomic and ecological. The emphasis of the criteria, however, fell clearly on exotic species, and on pathological and experimental morphologies, answering primarily to the concerns of professional and economic utility. When Harold Wager reported the Committee's initial deliberations to the BAAS Corresponding Societies in 1901, on behalf of the Botanical Section, he indicated a similar breadth in describing the kinds of photographs required, but reformulated the criteria in terms more accommodating to amateur botanists who had little access to travel or to professional laboratory expertise. He removed any emphasis on 'foreign plants' and overlooked morphological and experimental questions, indicating that the collection would need "photographs of rare plants growing in their natural habitats," as well as "characteristic formations of the various vegetation areas, such as moor, soft marsh, and so forth."[35] Expressed even in such familiar terms, however, most of his audience lacked familiarity with the concepts of plant formations and associations required for ecological work. For this constituency, the notion of 'plant portraits' was naturally more attractive than either laboratory work or generalised vegetation survey. Whilst ecological desires for photographs of vegetation were notionally accommodated, therefore, in practice

[34] BAAS 1903: 472

[35] BAAS 1901: 485-6. Wager was almost a perfect personification for the breadth and ambivalence of these criteria. His own botanical interests were principally morphological and physiological and therefore aligned with academic botany. He was a former lecturer in botany at the University of Leeds, son-in-law to his former professor Loius Miall, who chaired the Botanical Photographs Committee. The signatories to his recent nomination as a Fellow of the Royal Society included several of the nation's leading academic botanists, most of whom were his former teachers or colleagues. But he was also an active member of his local natural history society, and of the Yorkshire Naturalists' Union, alongside William Smith who succeeded him as lecturer in botany at Leeds, and Thomas Woodhead and the other Yorkshire ecologists from whom, along with Weiss, Wager doubtless heard much about plant associations and vegetation survey (Seward 1930).

most botanists, poorly attuned as they were to the kind of botanical vision required for picturing plant associations, ignored this criterion when submitting photographs for the collection.

In its first two years, 230 photographs were added to the collection and ecologists were active contributors. As they began to take control of the Committee, they made further efforts to promote the kinds of pictures required for vegetation study. When reporting the year's acquisitions in 1904, and again 1905, for example, they highlighted contributions that met this requirement in particular, including pictures from Tansley, Frank Oliver and other ecological colleagues.[36] Their frustration could only have intensified as most contributors remained reluctant or incapable of producing pictures of the required sort. In 1905, Frederick Weiss sought to overcome the inertia, and to encourage greater interest in ecological photography, by presenting a paper to the Botany Section of the BAAS on *Botanical Photographs as Aids to Ecological Research*. Such photographs, he said, were essential to obtain accurate records of the character of vegetation under different habitat conditions. "Not only does photography give the most truthful representation of plant form," he said, "it can be made to show the aspect of the surroundings to which any plant, or group of plants, has become adapted...and gives a clear idea of the features of any plant-association." Of course, all this could not be achieved with one photograph of a single plant; several general views of the same plant community should be taken, he said, as well as detailed photographs of each member of the plant association.[37]

By the following year, it was clear that there was too much confusion over ecological photographs and, as botanists continued to produce their customary plant portraits, ecologists decided that the required clarity could only be obtained by establishing a separate collection of photographs. Repeating a pattern they had already established for their vegetation surveys, having used the BAAS as an initial testing ground, ecologists now determined to further their own project by instituting parallel arrangements more closely suited to their needs. They did so by proposing that ecological photographs of British vegetation which were already incorporated into the BAAS Botanical Photographs Collection should be transferred to the British Vegetation Committee (BVC), and should be kept at UCL.[38] New vegetation photographs would be collected by the BVC and non-ecological photographs

[36] BAAS 1905: 345; BAAS 1906: 226.
[37] BAAS 1906: 592.
[38] The BVC had been established by William Smith and Arthur Tansley in December 1904, to bring together British vegetation workers. See *Professional associations* below.

would continue to be collected by the BAAS Committee, as a more strictly 'botanical' collection. The effect was to create two separate collections, one held by Tansley and Oliver at UCL, the other housed with Frederick Weiss at Manchester University, in his capacity as secretary to the BAAS Committee. The significance of the separation was underlined in 1907, along with Arthur Tansley's central role in the deliberations over ecological photographs in both committees. Tansley had moved, in the meantime, from UCL to Cambridge, and the BAAS Committee decided that a duplicate set of the entire collection should be made and held by the BVC at Cambridge. Not surprisingly, since the members of the BAAS Committee were by now all also involved with the BVC, the latter committee thought this an "excellent arrangement", deciding that there should in fact be two duplicate sets, one held by Tansley in Cambridge and a second with Weiss in Manchester, whilst the original vegetation collection remained with Oliver at UCL.[39]

The completeness of the separation was evident in the partial list of photographs registered to the BAAS collection and reported by the Botanical Photographs Committee's in 1907. All were straightforward 'plant portraits', taken in the field or 'in natural habitat', but none were referable to vegetation surveys or recognisable plant associations.[40] It seems no listing of the photographs in the *ecological* collection was ever circulated at the BAAS. This does not mean that ecologists ceased to collect photographs, merely that they no longer maintained links to the BAAS for these purposes. The dissolution of the Botanical Photographs Committee more or less coincided with that of the BVC and the latter collection passed into the care of a new British Ecological Society (BES) in 1913. It seems clear, however, that ecologists had resigned themselves to the impossibility of maintaining a photographic collection that could answer both to the preferences for 'plant portraiture' displayed by taxonomic or floristic botanists and their own need for visual records of plant communities.

One small success in promoting ecological photography came outside both the BAAS and the BVC, in the unlikely quarter of commercial lantern slide manufacture. In dissolving itself, the BAAS Committee reported that there had been a very limited demand for loans of the negatives and prints collected "due no doubt to the large number of photographs and lantern slides available from various dealers."[41] There was certainly no shortage of commercial suppliers able to provide lantern slides, for purchase or hire. Established lantern slide

[39] BAAS 1907: 433; BAAS 1908: 417; Smith 1907: 104; Smith 1909: 205.
[40] BAAS 1908: 418-21. The list included the last 70 pictures registered after the separation of the two collections, when ecological photographs were registered separately.
[41] BAAS 1914: 267.

manufacturers, such the London firms of Newton & Co. and Young and Sons supplied slides for lectures under titles like 'Flower studies from nature', 'Orchids and wild flowers', 'Alpine plants' and 'Botanical slides'. Similar collections were available from Flatters and Garnett in Manchester, who advertised slides covering 'British flora in nature'. More notably for ecologists, Flatters and Garnett also listed in its catalogue a set of over 80 slides for a lecture on *The Geological Botany of Dr A.F.W. Schimper*, and a set of at least 150 photographic slides to illustrate *British plant associations: the 'Crump' series.*[42] The company advertised these slide sets specifically under the rubric of 'Plant Associations'. Flatters and Garnett were scientific instrument makers, specialising in microscopy, with close connections to the University of Manchester (as their advertisements intimated). As Professor of Botany, it is more than likely that Frederick Weiss had regular dealings with the company for the supply of both lantern slides and other equipment, and the appearance of these sets in their catalogue may well reflect Weiss's influence. It is no accident either that advertising for the company's plant associations series appeared in *The Naturalist,* the journal of the Yorkshire Naturalists' Union, where William Smith and others were particularly active in promoting ecological vegetation studies. Lantern slides were also advertised in *The Naturalist* from J. Holmes of Rochester, in Kent, highlighting 'Botany (including Plant Associations)' as a specialty.[43] In the event, however, these advertisements marked only a fleeting high point of awareness regarding ecological vegetation study among the wider British botanical community. It did not last. J. Holmes' advertisements in *The Naturalist* appeared for just six consecutive issues, between December 1911 and May 1912.[44] Flatters and Garnett continued to post adverts intermittently after this date, but made specific reference to plant associations in only two consecutive issues in December 1912 and January 1913. When their advertisement next appeared, in October 1913, 'plant associations' did not feature.

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[42] *LUCERNA*, T*he Magic Lantern Web Resource* http://www.slides.uni-trier.de/organisation/index-mfr.php?id=1000763 [Accessed 8 Apr 2016].

[43] *The Naturalist,* Dec. 1911, Jan-May 1912, Dec 1912, Dec. 1913. The 'Crump' series remained listed in Flatters and Garnett's catalogue for many years and was still available for hire in 1933, at a special price to members of the Yorkshire Naturalists' Union of 1s. 3d. each (ordinary price 1s. 6d.) (J. *Ecol.* 1933a: 488).

[44] The highpoint of availability for these collections followed the successful International Phytogeographical Excursion (IPE) of 1911. The IPE was a field-based gathering of professional botanists and ecologists, instigated by Arthur Tansley in June-August 1911 to exchange knowledge and experience across national and continental borders. The January 1912 issue of *The Naturalist* also carried a review of *Types of British Vegetation,* the first monograph on British plant associations, which had been published especially for the IPE, with J. Holmes' advertisement appearing on the back cover of the same issue. For more on the IPE, see later in *Outdoor associations.*

Fig. 3.1 George Pethybridge. *Ammophila arenaria forming embryonic dune, North Bull, Dublin, 1903*. BES Tansley Photographic Collection. PET/1.

Ecologists did not stop taking or collecting photographs but their negatives and prints remained largely in private collections, maintained as personal records. They continued to make use of photographic presentations at meetings and conferences, frequently exchanged photographs with colleagues, and made extensive use of photography in printed publications. The BVC ecological collection, notionally at least, remained available to other ecologists through the BES. In practice, it was added to or used by only a few individuals, in particular Arthur Tansley in Cambridge, into whose care the collection had been given. To all intents and purposes, in time it became Tansley's own collection, elements of which have survived in the Tansley Photographic Collection now held by the BES at its London offices.[45] The Tansley collection now consists of 1,208 different prints, together with numerous duplicates and negatives, dating from 1897 to around 1940, and mostly restricted to the British Isles. Nearly 300 of the prints are from photographs taken by Tansley. The others come mostly from other ecologists but include also a small number obtained from *The Times* newspaper and a few postcards. Tansley's primary purpose in amassing the collection was for use in publications. His comprehensive monograph on *The British Islands and their Vegetation,* published in 1939, included 418 photographs, of which 193 have been located within the collection. A number of these and others were also printed in others of Tansley's books and published papers and many more from other authors, especially those publishing in the *Journal of Ecology,* which Tansley edited from 1917-1938.[46] Seen from the point of view of botanical photographs, the collection is noteworthy for an almost complete absence of portraits of individual plants or species, justifying the label carried by the collection before its re-housing at the BES, as 'The Vegetation Photographs of A.G. Tansley.' In a typical example (Fig. 3.1), an early phase of development in sand dune vegetation emphasises habitat conditions and vegetation structure over any potential species interests.

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[45] Sheail (Unpubl.). No clear line of descent can be traced between the original BVC collection and the current Tansley Collection at the BES. Circumstantial evidence suggests that at least some of the material is the same, however, since the BVC collection was given into Tansley's hands and the current collection includes a number of photographs dating from 1897-1906, some mounted on card as recommended in the Committee's guidance. Today's Tansley Collection derives from a pair of boxes marked 'The vegetation photographs of A.G. Tansley' given by Tansley's daughter, Margaret Tomlinson to what was then the Nature Conservancy, some time after his death. In 1972, the boxes of photographs were referred to in internal minutes of the Conservancy, suggesting they might be used for publications. At some point in the many organisational changes experienced by the Conservancy in the next quarter-century, the collection was passed to the British Ecological Society where it remains as the 'Tansley Photographic Collection'.

[46] See chapter 4 on the *Print cultures of ecology*.

As Flatters and Garnett's 'Crump' series suggests, other private collections were being made by individual ecologists. William Bunting Crump (1868-1950) had been a student of William Smith at Leeds. He was also a member of the BVC and became one of the founding council members of the BES in 1913. As an extension of his ecological interests, Crump was also a keen photographer. He assisted in Smiths vegetation surveys in Yorkshire and accompanied Charles Moss (another of Smith's students) over a number of summers, from 1903-1906, assisting in survey work and producing photographs of vegetation in Somerset. His photographs were included in a number of publications by Tansley, Smith and others.[47] Crump toured numerous parts of England especially, in search of typical views of a wide range of vegetation types, and built an appreciable personal collection (Fig. 3.2 overleaf). In 1933, the *Journal of Ecology* carried an editorial, informing members of the BES of a gift to the Society from Crump of his vegetation collection, comprising about 200 negatives, with corresponding prints and lantern slides, including "many characteristic views of native vegetation as well as some plant portraits." If the collection survives, its current whereabouts are unknown.[48]

The only other surviving British ecological photographic collection recently came to light at the British Natural History Museum. Its creator was Edward James Salisbury (1886-1978).[49] One of Britain's earliest ecologists, Salisbury was also a taxonomic botanist and felt no tension

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[47] Crump and Crossland 1904; Tansley *et al* 1911a, Tansley 1939, Tansley 1949; Smith and Moss 1903; Smith and Rankin 1903; Cavers 1918.

[48] J. *Ecol.* 1933a: 488. The collection came pre-arranged by Crump according to the classification of British plant communities established by Tansley and others in preparation for the widely advertised IPE of 1911 (see *Outdoor associations* below), and including examples of maritime associations, freshwater, swamp, fen, heath and moorland, as well as a range of woodlands and grassland vegetation types from almost twenty different counties of England and Wales. The collection was housed initially at Oxford University's Department of Botany, where Tansley had been Sherardian Professor since 1927. There appears to be no subsequent record of the Crump Collection, either with the BES or Oxford University's Radcliffe Science Library and Sherardian collections, which house the former botany department records.

[49] A further candidate 'ecological' photographic collection is that of Robert Moyes Adam (1885-1967), held at St. Andrews University. The Moyes Adam collection dwarfs those of both Tansley and Salisbury, including over 14,500 half-plate and quarter-plate glass negatives. Acquired by St. Andrews from the publishers of *The Scots Magazine*, the acquired collection included only negatives but was said originally to have included 60,000 prints (Matthews 1968). Adam was employed by the Edinburgh Royal Botanic Garden and his photographic work was used by academics to illustrate their University lectures. He was a keen botanical naturalist, a member of the Edinburgh Botanical society and its Alpine Botanical Club, and of the Edinburgh Field Naturalists' and Microscopical Association. His pictures cover a wide range of Scottish landscapes, their flora and fauna and geology. However, whilst they have been used widely in accounts of Scottish landscape, natural history and ecology, Adam himself was a general naturalist and enthusiast for Scottish scenery, not an ecologist. His botanical pictures consist overwhelmingly of plant portraits.

between the two. Salisbury began taking photographs of vegetation and plants as early as 1913 and continued for most of his life, amassing a collection of over 1,400 images, made almost exclusively on silver gelatin glass half-plates. Like Tansley, Salisbury incorporated photographs into his academic publications in ecology and botany and this was undoubtedly a primary objective in building the collection. He also used his photographs to illustrate lectures and talks, as a teacher and academic, as well in professional and amateur society meetings elsewhere.[50]

Fig. 3.2. W.B. Crump. *Hardcastle Crags, Hebden Bridge, Yorkshire. Sessile oakwood association, c.1903.* BES Tansley Photographic Collection. CRU/1.

[50] *Proc. Linn. Soc.* 1915: 2; J. *Ecol.* 1933c: 222-223; Clapham 1980. An enthusiastic species recorder from early in life, Salisbury was a student and junior colleague with Frank Oliver at UCL from 1905, and finally Oliver's successor as Professor of botany. With Oliver, he undertook pioneering ecological work in coastal habitats and, on his own account, produced some of the earliest investigations of woodland ecology. He also became a member of the BVC and then a founder member and mainstay of the BES. At the same time, he was at home amongst amateur botanists, taking a very active role in the Hertfordshire Natural History Society and, latterly, the Norfolk and Norwich Naturalists Society. He was also a keen gardener, and it was this combination of skills and interests that led him ultimately to the position of Director at Kew Gardens from 1943 to 1956. Salisbury's plates, which came to light almost a century after the first of them was exposed, were stored in their original boxes, labelled and arranged variously by habitat, by taxonomic grouping or by geographical location. Most of the plates are accompanied by silver gelatin contact prints, made for ease of reference in lieu of the rather more difficult viewing of glass negatives. The individual plates carry a range of handwritten markings, including species names, the date of exposure, a habitat or geographical location, and a serial number. Otherwise, the collection appears to have been stored without documentation.

After 1950, he also published popular botanical books which were generously illustrated with his photographs. Nevertheless, only a small fraction of the collection was ever used in this way and his photographic practice, whilst clearly related to academic studies, was also an autonomous personal project for building a systematic collection of photographs for British vegetation types and plant species. As well as vegetation types or general habitat views (Fig. 3.3 overleaf), the Salisbury collection includes close views of individual plants which, like the botanical photographers who contributed to the BAAS collection, Salisbury was happy to call 'plant portraits' (Fig. 3.4 overleaf). In a long career, Salisbury successfully combined ecological vegetation study with taxonomic botany and moved effortlessly between the two. The ease with which he did so is reflected in the collection, and also in his own memories of the early history of British ecology. "The study of plant communities provided the taxonomist with new realms to conquer," he recalled. "Those taxonomists...found in descriptive ecology a fresh outlet for their legitimate ambitions, and for the exercise of their expertise, in the identification and listing of the species that were associated together."[51] For ecologists like Salisbury, there was no problematic separation between species and association. As fieldworkers, they routinely recorded plant species as a route to constructing the plant community.

By contrast, epistemic ambiguity ran through the BAAS Botanical Photographs scheme from the start and reflected the more general epistemological ambivalence that many botanists felt when faced with the concept of the plant community. That ambiguity was evident in the rapid schism of the resulting archive into two separate collections, one for plant portraits and another for plant associations and other features of vegetation. The same difficulty is likely to have limited the success of commercial lantern suppliers, who thought they had spotted a market for the sale of photographs depicting plant associations, when the interest of most botanists continued to lie with the individual species and its varieties. This difficulty should not have been inevitable. Ecologists after all were also botanists, by inclination and training, but saw no difficulty in accommodating the plant species and the plant association as complementary concepts. The private collection of Edward Salisbury provides a particularly coherent expression of this complementary outlook, but it was clearly shared by others. Some ecologists, like William Crump and Arthur Tansley collected vegetation photographs almost exclusively. Others, like Salisbury happily went out into the field to record and photograph a wide range of plants, the common as well as the rare, not

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[51] Salisbury 1964: 15.

Fig. 3.3. E.J. Salisbury. "Dinmore wood transition zone, *Q. sess* above with spars *Pteris et cet*, *Fraxinus* below on slope with *Merc p.*", 1922. E.J. Salisbury Collection (Item no. BM001162542), Natural History Museum.

Fig. 3.4. E.J. Salisbury. *Menyanthes trifoliata* "Plant portrait", Undated. E.J. Salisbury Collection (Item no. BM001162900), Natural History Museum.

solely for their interest as species, but for what they could reveal about plant associations and habitat. This suggests that the epistemic confusion of other botanists, and their ambivalence towards plant communities, lay not in a deep ontological divide between plant species and plant associations, but in the division between the communities of interest within which these competing conceptions were sustained.

Professional associations

At a national level, activity at the British Association brought Britain's first ecologists closer together in their endeavours to develop a coherent viewpoint. In the years following 1904, they continued to bring their work to the British Association's annual meetings. Their hopes of bringing ecological ideas and discussion to a wider botanical community were also at least partly rewarded. Key ecological figures, including Tansley, Frank Oliver, and Richard Yapp, became members of the BAAS Botanical Section Committee during these years. As professional botanists, Tansley, Smith, and most of their ecological colleagues, involved themselves in every sector of the institutional life of British botany. That life lacked its own credible national institution, but many leading botanists were Fellows of the Linnean Society, and this provided ecologists with a further target for persuasive rhetoric.[52] Following the solid ecological front presented at the BAAS in 1904, for example, Tansley was invited to lead a discussion on ecology at the Linnean Society.[53] Other key ecologists were also Linnean Fellows, whilst Tansley, Oliver and later Moss, all held seats on the Society's council and its library committee. At the same time, ecologists took office on the councils, committees and editorial boards of other societies. Frank Oliver sat on the editorial board for the leading journal for academic botany, the Annals of Botany, from 1912, whilst William Smith and other ecological botanists were councillors and editors for the Botanical Society of Edinburgh and its Scottish Botanical Review. Smith was vice-President in 1913-14 and President in 1921-22. In these capacities, they brought wider exposure to ecology, especially among professional botanists.

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[52] The nearest thing to a national botanical society at this time was the Botanical Exchange Club which, as its name suggests, was really only a means for collecting botanists to swap specimens and records. See Allen 1986 for a full account of the history of what ultimately became the Botanical Society of the British Isles.

[53] Cambridge University Library, Arthur Tansley Papers, Public and Invitation Lectures. MS Tansley E.5 4 May 1905. 15pp manuscript draft + manuscript notes.

Such inroads were slow to develop, however. In 1904, the most pressing need was to progress work that was actually ecological in character and Tansley repeated earlier calls for a central co-ordinating authority for vegetation survey. He no longer called for a new committee of the British Association, however, preferring instead an independent committee. By now, he had seen what could be achieved in survey work by individuals or in small groups. William Smith's work in Yorkshire was particularly persuasive in this respect. However, the inherent difficulty which floristic botanists found in taking a new view of vegetation was proving a significant inhibition to progress. Smith and Tansley agreed that the best way forward was to bring together the expertise and energies of those already actively engaged in ecological study.[54] Shortly after the 1904 BAAS meeting, therefore, Smith invited all active British vegetation workers to a meeting at his home in Leeds. Together, this small group (amounting to fewer than 10 individuals) constituted themselves under the somewhat ponderous title of the Central Committee for the Survey of British Vegetation, with the aims of co-ordinating and standardising their own survey work, and promoting further vegetation studies of all kinds.[55] Almost straight away, it was agreed that Smith should write a pamphlet for the Committee on *Suggestions for Beginning Survey Work*. The resulting pamphlet, published in the *New Phytologist,* restated the proposal for national vegetation survey and offered the assistance of members to others wishing to undertake new surveys. Clearly addressing a professional audience, Smith once again differentiated the work of vegetation

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[54] Tansley 1904a: 198. Tansley's call for a central committee is not reported in the proceedings of the BAAS, but he later recalled having spoken to this effect (Tansley 1947). The suggestion appeared in the published version of Tansley's paper, in October 1904. As a result , Tansley has been credited with the establishment of the Committee (Godwin 1957: 234). In fact, Tansley never claimed this credit for himself and it seems likely that Smith was the immediate motivator for the meeting, which convened at his house in Leeds on December 3rd. According to the BVC Minute Book for December 1904, the meeting was called on the initiative of both Smith and Tansley. BVC Minute Book Dec. 1904 (BES/MB/2); Nottingham (Unpubl.).

[55] BVC Minute Book, 1904 (BES/MB/2); Tansley 1947; Sheail 1987: 23. The meeting at Smith's house in Leeds took place on Dec. 3rd 1904, and was attended by both William Smith and Arthur Tansley. They were joined by Smith's followers Charles Moss and Thomas Woodhead. A further five (making a total of nine) are recorded as founding members of the committee, though they were unable to attend the first meeting. These included Marcel Hardy and Francis Lewis, who had both been inspired by the Smith brothers to undertake vegetation surveys in Scotland and northern England; William Munn Rankin (another of William Smith's former students); and Robert Lloyd Praeger and George Pethybridge from Dublin. From the third meeting, the group was joined by Frank Oliver, Quain Professor of Botany at UCL, where Tansley worked as his Lecturer. At subsequent meetings, further members were added, including another of Smith's Yorkshire associates, William Bunting Crump, the Huddersfield born Frederick Weiss who had been immediate predecessor to Tansley at UCL and was now professor of botany at the University of Manchester; lichenologist Otto Darbishire, lecturer at Manchester under Weiss; and Richard Yapp, professor at the University of Aberystwyth. Further later additions included Associate members who came to the committee's attention for specific contributions to vegetation studies.

survey from floristic work, by reference to the authors of well known British floras, Bentham, Babington and Hooker. He contrasted these icons of establishment botany with the less well known proponents of ecological vegetation study, including Andreas Schimper and Carl Schröter, before reiterating some fundamental ecological concepts on vegetation formations, plant associations and outlining the broad methodological approach recommended by the Committee for vegetation survey, mapping and detailed autecological studies.[56]

Second and third meetings followed quickly in 1905, demonstrating an enthusiasm that was maintained at every meeting for almost a decade, during which time they changed the committee's name to the less unwieldy and more accurate British Vegetation Committee. For much of the next decade, the members of the BVC consolidated and extended the vegetation survey work begun by the Smith brothers and began more detailed studies of vegetation and the environmental adaptations of plants. All but one of the founding members were professional botanists and college or University lecturers; all were actively pursuing vegetation study of one kind or another. Despite being spread across the country, the committee met regularly, sometimes as many as three times in a year. They discussed and compared their progress in survey work and, through their growing familiarity with British vegetation types, their understanding of the nature of vegetation communities in general. They discussed survey methods and the practicalities of maps and mapping work, including questions of scale and the development of a standard colouring scheme for denoting different kinds of vegetation. They presented their work to one another in semi-formal seminars and open discussions, making the fullest possible use of visual technologies of record, reporting and display. Chief among these were maps, both draft and finished, as well as lantern slides and photographic prints, sketches, diagrams and tabulated data.[57]

The Committee also kept under constant review the matter of photographic collections, in particular that organised by the BAAS Botanical Photographs Committee whose members, as we have seen, also sat on the Vegetation Committee. Underlining the distinction between the BAAS collection and their own ecological requirements, the Committee emphasised its view that photographs in the collection should "illustrate a definite association or feature of

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[56] Smith 1905a. *Autecology:* the ecological study of individual organisms, species or populations, as opposed communities.

[57] The progress of the BVC is related by several of its participants (Tansley 1947; Salisbury 1964) and rehearsed by several subsequent ecologists and historians (Godwin 1977; Lowe 1976; Sheail 1987; Ayres 2012). Kaat Schulte Fischedick (2000) has attempted a more critical assessment of the Committee's success, focussing on what she sees as conflicting aims as the Committee shifted away from survey work towards more detailed ecological studies.

an association, or a definite plant form characteristic of an association."[58] This stipulation governed their own photographic practice, and all committee members used photography extensively in their own vegetation survey and other ecological researches. In a variety of forms, photographs and other visual materials were constantly before them in meetings, viewed on the screen or circulated hand-to hand. Through photographs, they witnessed the sites of one another's study, and the detailed character of vegetation in those locations. They considered the geographical distribution of the plant communities so witnessed. They tested one another's judgement regarding particular plant associations and discussed the robustness of the plant association as an idea, as well as the terminology appropriate for describing associations and related concepts in the study of vegetation. Photographs provided the evidential basis for all these kinds of discussion, allowing real examples of vegetation to be adduced as corroboration for diagnostic judgement and in support of theoretical assertions regarding the range and appropriate classification of different vegetation types.

Examples from just a few meetings give a sense of the critical role of photography in the work undertaken by all the Committee's members as they shared and compared photographic samples of vegetation from all over the British Isles. Charles Moss showed photographs in connection with his surveys in both Derbyshire and Somerset; Francis Lewis showed photographic work from peat mosses in Scotland and northern England, whilst William Smith, William Rankin and Thomas Woodhead all reported on work from Yorkshire and Robert Lloyd Praeger from Irish surveys. Richard Yapp had also been conducting work at Wicken Fen near Cambridge since 1903 and was rarely without his camera. Later sessions included work from Marietta Pallis in Norfolk and E.J. Salisbury's studies in both coastal and woodland habitats. Frank Oliver's detailed studies of coastal vegetation in Norfolk and Brittany included extensive photographic work, for which Oliver regularly used a panoramic film camera. Oliver and Tansley also used photographs to illustrate new methods for detailed ecological studies, in coastal and heathland habitats respectively. In most cases, these photographs were taken by ecologists whilst conducting their vegetation surveys but some, perhaps less confident of their camera skills, called on others to ensure that adequate photographic work accompanied their ecological accounts. Charles Moss was supported in this way by William Crump, whose collection of vegetation photographs, as we have seen, gained wider currency outside the BVC. Robert Praeger, working in Ireland, was assisted by the noted Irish naturalist and photographer Robert Welch. Finally, Oliver's Brittany work,

[58] Smith 1905b: 25.

undertaken in collaboration with Tansley and others, included assistance from additional 'photographic specialists', covering experimental colour work as well as general vegetation photography.[59] Many of these photographs were also reproduced in the published accounts of BVC members' work. A number of photographs in the BES Tansley Photographic Collection can be confidently ascribed to these workers and their vegetation studies in this period (Figs. 3.5-3.8). The collection as a whole provides a substantial sample of the range of ecological vegetation photographs, including examples from many of these early vegetation surveyors.

Fig. 3.5. W.Munn Rankin. *Ash colonising fissures in eroded limestone pavement, Chapel-le-Dale, Yorkshire, c.1905.* BES Tansley Photographic Collection. RAN/1/2.

[59] Smith 1905c, 1907; Praeger 1906; Oliver 1907. See both chapters 4 and 5 for further discussions of Oliver's Brittany project.

Fig. 3.6. A.G. Tansley. *Staffhurst Wood, Surrey. Oakwood association (prevernal aspect). Primula vulgaris on Wealden Clay, April 1905.* BES Tansley Photographic Collection. TAN/4/1.

Fig. 3.7. R. H. Yapp. *Old pool in marl pit, near Upware, Cambridgeshire, c.1903* BES Tansley Photographic Collection. YAP/8 (F41).

Fig. 3.8. *Marietta Pallis. Detail of fen association in East Norfolk, c.1908.* BES Tansley Photographic Collection. PAL/2.

In the context of BVC meetings, these photographs were not simply illustrative. That is, they were not expected, simply by showing, to confirm a surveyor's judgement of what he saw. Rather they were visual tools for thinking and speaking about plant associations and ecological conditions. Of course, photographs could not show all that might be seen, but they were expected to give access to real examples of vegetation, enabling ecologists to see what the photographer saw as he moved through the landscape and sketched the outlines of different plant communities onto a map. In photographs, the physiognomy and species composition of particular stands of vegetation could be witnessed, interrogated and even contested by others. Whether through lantern shows or as prints, physically passed among the members of the group during meetings, photographs became active instruments for constructing ecological knowledge and shared understanding, about plants, plant communities and their ecological characteristics. Importantly, photographs gave ecologists shared access to a much wider range of sites and types of vegetation than any one of them could hope to visit and survey alone, enabling comparisons and extending a general understanding of British vegetation.

This haptic use of photographs, in the context of informed discussion, attests to the sociality of scientific understanding and to its sensory mediation through photographic objects. In other contexts, such sensory engagement with photographs has been understood to allow the formation and communication of subjective experience in relation to the photograph and its subject, and to mediate shared experience between the users of photographs as they are viewed and handled, passed along, touched, pointed at and talked to.[60] The exploratory and discursive value of photographs in these social settings facilitates inter-subjective experience and a common or shared understanding. Ecological talk over photographs helped to reify plant associations in general, and specific examples of vegetation, as shared objects of study and understanding. Elizabeth Edwards has observed that, in the detached contexts of archives, subjective readings of survey photographs were regulated by constraining the haptic experience of viewing and handling photographs.[61] Similar archival practices of mounting, labelling and cataloguing were promoted by BAAS committees for photographic collections more broadly and, albeit less rigorously, for the BVC's collection of ecological photographs. Such regulation was a guide to sensory engagement and understanding in proscribed ways, in the absence of an original observer or

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[60] Di Bello 2007; Rose 2010; Olin 2012.
[61] Edwards 2014a.

other expert viewer. In the congenial circumstances of BVC meetings, this problem did not arise, because the author of the photographs was usually present to provide context and interpretation. The apparent absence of regulation in this viewing context did not indicate consensus regarding the content or meaning of photographs; rather it opened photographs to contest and debate. Information content and meaning were established, and the reality and character of ecological objects fixed, precisely through discussions over photographs. In other contexts, ecological photographs were rarely expected to function in the absence of guided readings, provided by the expert on-hand or in the discursive context of published work, supported by verbal accounts, data and other forms of visual argument. In the few examples where photographs were required to function with a high degree of autonomy with regard to ecological meaning, as we will see in the next chapter, their meaning became epistemologically unstable, unable to distinguish clearly between floristic botany and the ecology of plant associations.[62]

Photography occupied the visual centre of the BVC's work, but it did so alongside mapping. Vegetation mapping was, after all, one of the Committee's primary objectives. However, the theoretical centre of vegetation ecology — for both photography and mapping — lay in the field. The important thing in vegetation survey was the recognition and delineation of real plant associations, geographically located within a landscape under the influence of a range of habitat factors. That meant going out into the field to make direct observations. Unlike floristic phytogeographers, whose aim had been to catalogue individual species and their geographical distribution, and who collected and brought home specimens for this purpose, it was not open to ecologists to bring their objects of study home. Instead, they brought home visual objects — maps and photographs — to fix their field observations and make them communicable to others. The members of the Vegetation Committee placed particular value on these 'immutable mobiles' because they permitted shared access to the field, the ultimate authenticating point of reference for all ecological study.[63] Though an individual could not physically experience all of Britain's fascinating places of ecological interest; through photographic proxies and mapping, personal experience could extend to sites visited by others. Wherever and whenever possible, however, ecologists realised their conviction in the importance of shared field encounter by undertaking site visits together. If

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[62] See chapter 4, in particular *Die Vegetation der Erde*.

[63] For further consideration of vegetation maps and photographs as Latourian 'immutable mobiles', see *Sketching knowledge* in chapter 5.

they were to come to a common understanding of vegetation, even photographs were a poor substitute for going out to look at the real thing. The physiognomy, detailed texture and composition of vegetation, and its physical habitat characteristics, could only be appreciated fully through direct contact with real examples. Common recognition, common distinctions between plant communities, common methods of study, all required common field visits. Standing before the object of study, ecologists could test their theories of plant association, vegetation character and development. They could test also the visual tools and verbal descriptions they used to represent vegetation to one another, and to other botanists. Together in the field, they ground-truthed their photographs and species data, their mapping of vegetation types; they shared and confirmed knowledge with their peers, and confirmed the field as the primary locus of ecological knowledge-making.

The importance of such field meetings was underlined very early in the BVC's life. Meetings were held at a range of different locations, to provide access to a wide range of landscapes and vegetation types. Almost every meeting was arranged to allow field visits to view examples of local vegetation, under guidance from a member familiar with the locality. Initially, these field excursions extended to one or two half-day trips but meetings routinely spanned a couple of days precisely to allow time for such outings. Soon the field excursions assumed greater prominence, becoming both longer and more elaborate.[64] As early as 1907, the Committee resolved to spend a full week in the field, for a meeting organised to coincide with the BAAS meeting for that year. In the event, 1907 saw two separate field excursions, to Surrey and to Derbyshire. When the group met in Ireland in 1908, the field trips lasted almost a week. In 1911, when the Committee was hosted by Richard Yapp at Aberystwyth, the Committee spent almost three full days in the field. I will turn consider the shortly excursionary practices of ecology shortly, and the visual field methods of ecologist in detail in chapter 5. Here I want to note only that such fieldwork was most often a shared activity. Not only did ecologists visit their study sites together, to observe 'in company' with others, and to discuss what they saw, their primary fieldwork was commonly undertaken in collaboration or with the assistance of others, even when they are not fully acknowledged in written accounts. This meant that visual practice, scientific record and interpretation, were always to some extent negotiated between practitioners in the field. Ecological method and judgement were the outcome of shared encounter in the field, subsequently mediated through mapping and photography.

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[64] Praeger 1906; Smith 1909, 1912; *New Phytologist* 1908: 253-260.

Ecological associations

From its first meeting, and repeatedly thereafter, the BVC considered the possibility of extending its membership to encourage a wider community of ecologically-minded botanists.[65] For several years, they did nothing to increase the size of the Committee, or its scope of work, feeling that impetus would be diminished if membership were extended to individuals who were not actively involved in ecological investigations. The membership did change, as a few ceased vegetation work or moved overseas, and as new workers entered the field. From 1909, an associate membership was instituted, to encompass a few advanced students who were beginning to make notable contributions to vegetation study. By 1912, however, the emphasis of the Committee's work had shifted somewhat, away from broad-scale survey and mapping, towards more detailed vegetation studies, including autecological studies of individual species and physiological work. The Committee's members had experienced considerable difficulties in getting vegetation surveys published, largely due to the cost of reproducing large-scale colour maps. They were more confident of success, however, in achieving their aims in relation to more detailed ecological investigations. Reporting progress early in 1912, William Smith expressed the Committee's optimism, looking forward to "even greater and more widespread activity."[66] Over the following months, the Committee reconsidered its scope and membership and agreed to dissolve itself in favour of a new British Ecological Society (BES).[67] The new ecological society, the first of its kind in the world, had its first general meeting on April 12 1913 and, after a first successful year, optimism still ran high. In his first Presidential address in May 1914, Tansley expected a bright future for ecology, declaring that "we may confidently expect to see it take a progressively larger place in the development of the botany of the future."[68]

The transition from Vegetation Committee to Ecological Society did not interrupt the group's now customary meeting practices. The Society quickly developed a rich visual and material culture of presentation at its formal meetings and, later, in less formal soirées and conversaziones. In fact the range of material on display expanded considerably as the maps and photographs of the BVC were reintegrated into a broader culture of natural history

[65] Smith 1905b, 1909, 1912; BVC Minutes, 24 April 1909, British Ecological Society Archives, cited in Cameron and Matless 2011: 20 (nn.19).
[66] Smith 1912: 103.
[67] *J. Ecol.* 1913: 132. The eleven full members of the Committee became the new society's first Council. Arthur Tansley, Frank Oliver and William Smith were elected as President and Vice-Presidents respectively. William Smith was also elected a life member.
[68] Tansley 1914: 202.

exhibition and scientific demonstration. Lantern slides and prints, maps and drawings, sections and diagrams, were shown alongside herbarium specimens, preserved animals, cased insect collections, soil samples, fossils, models, microscope slides, experimental apparatus and field equipment, as well as living plants, both ordinary specimens and experimental subjects. Photography remained central, however, and from the very first full general meeting in September 1913, was by far the commonest form of presentation. That meeting was a short one, really just a preliminary to the field excursions planned for the following day. William Smith gave a talk on Danish vegetation, following a recent excursion arranged by the Danish Botanical Society. Then members heard from Frank Oliver on shingle habitats, and some early animal ecology work, at Blakeney in Norfolk. The site was by now very familiar to Oliver's audience since he had been conducting research there since at least 1908. The work included photographic records at every stage, many of which Oliver had already shared with others. Oliver showed a particular inclination, at Blakeney and elsewhere, for views taken with a panoramic camera, which lent themselves to the expansive character of the coastal shingle habitat (Fig. 3.9 overleaf). The resulting images were used to illustrate a number of his subsequent publications.[69] William Rowan, one of the zoologists on Oliver's research team, used photography for a number of micro-studies, including the effects of rabbit grazing on vegetation, and a study of nesting terns. In the latter case, he used photographs not only to observe birds and their nest-sites, but to make a comparative study of the mottled patterns of their eggs. He was so taken with the photographic aspects of his project that he had copies printed on postcards (Fig. 3.10 overleaf).

Over the following decade, meetings became progressively longer and more involved. The number of short papers read at each meeting increased and larger and more complex exhibitions were organised, for both summer meetings and indoor winter gatherings. It was here that the visual and material discourses of ecology were most evident. At the Society's first official soirée, in January 1925, some 100 members and their guests were hosted by Frank Oliver and the Botanical Department at UCL.[70] Exhibits included rare plants from Kew, demonstrating the effects of xerophytic habitat conditions, as well as numerous other plants, both living and dried botanical specimens, showing species characteristic of different habitats or demonstrating adaptation to particular ecological conditions.

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[69] Oliver 1912; Oliver and Salisbury 1913a, 1913b; Carey and Oliver 1918.

[70] *J. Ecol.* 1925: 168-173. Such soirées also make apparent the extent to which ecology shared its cultures of social exchange and display with the established practices of amateur field natural history. See the following *Amateur associations* and *Taking to the field* later in this thesis.

Fig. 3.9. F.W. Oliver. *Sheep feeding on Silene maritima at the end of a long drought. Chesil Beach, near Burton Bradstock. September 1911.* BES Tansley Photographic Collection. OLI/2/1.

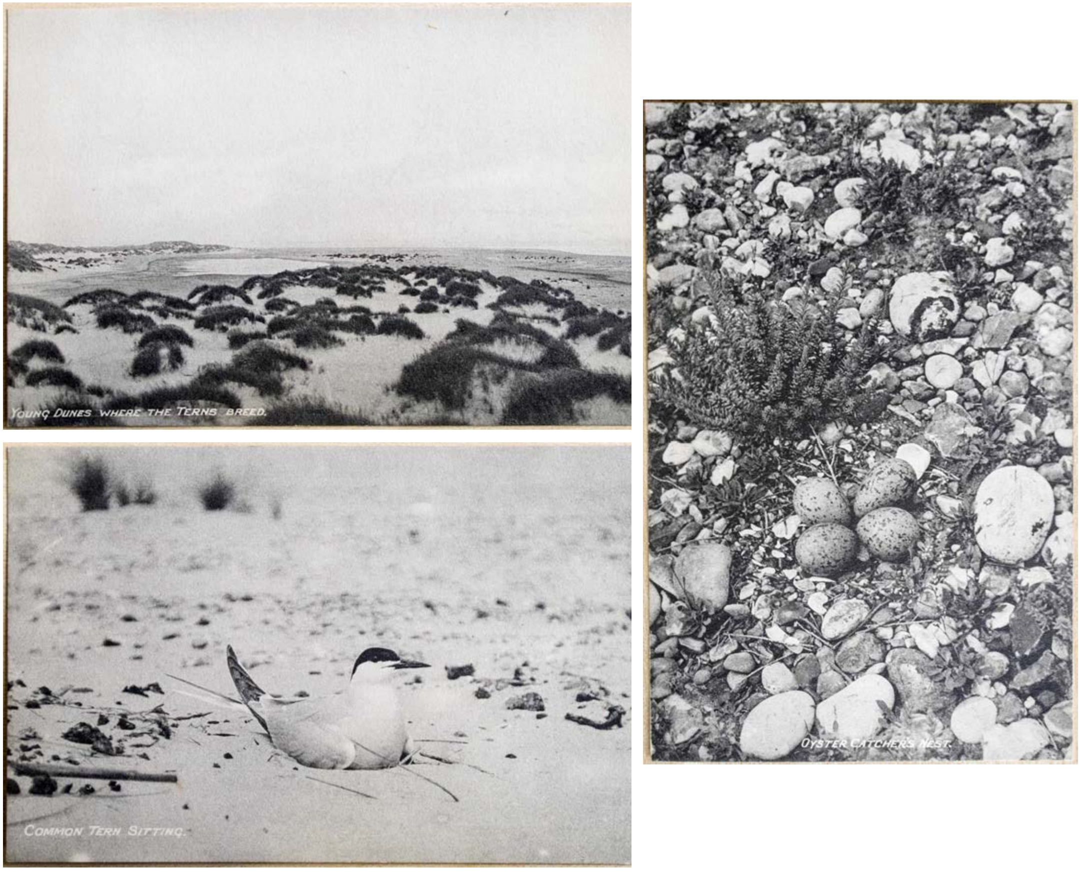

Fig. 3.10. W. Rowan. *Blakeney Point picture postcards. c.1908.* BES Tansley Photographic Collection.
Young dunes. ROW/3 (Top left)
Nesting Common tern ROW/4 (Bottom left)
Oyster catcher's nest ROW/6 (Right)

Other exhibits included a relief map to show the distribution of woodland vegetation types in North Wales, alongside a "series of ecological photographs of the same region."[71] Edward Salisbury showed a series of life-size drawings of the root systems of woodland plants to demonstrate their distribution in relation to soil conditions.[72] Frank Oliver displayed recent research on the spread of a new species of coastal grass, in which he had used photographs as critical evidence. Vegetation maps were shown by some, although this aspect of ecological work was somewhat diminished by this time. Thomas Woodhead also used maps, however, together with specimens, to demonstrate the relationship between prehistoric vegetation and human activity. Among the ensuing talk, Frank Oliver also gave a lantern lecture on the birds of Blakeney Point and Richard Yapp gave the meeting's first paper, on the formation of frost on leaves, "illustrating his remarks with a series of beautiful photographs."[73] Similar formal exhibitions continued routinely at larger Society meetings for several decades and underscored the importance of visual methods in making and exchanging ecological knowledge. Less easy to discern, but doubtless equally significant, were the countless informal exchanges between individuals or in small groups, supported by visual and other material evidence, at Society meetings and elsewhere.

Other innovative, non-photographic but highly visual displays demonstrate the important role of visual methods in ecological knowledge exchange. From the earliest vegetation surveys, maps had been used to provide graphic representations of the distribution of plant associations across geographical space. However, the distribution of vegetation was not always easy to relate to topographic variations such as slope, aspect, and relative altitude. In the case of the Welsh woodlands display at the 1925 soirée, this difficulty was partly met by the use of relief maps, together with photographs, to combine visual impressions with graphical representations of topography. A more visually immediate method had been demonstrated by William Smith in 1915, in the form of a relief model, constructed to show the topographic relationships of upland heather and grassland 'flushes' with drainage and other surface features. In addition, in an exhibit that recalls Humboldt's Ecuadorian tableau of Mt. Chimborazo, Smith showed a series of cross-sectional elevations, placed in sequence one behind another, coloured to show the altitudinal distribution of major plant communities across different parts of Britain. The effect was to present "a striking and effective 'bird's-eye

[71] Ibid.: 173.
[72] The drawings were reconstructed from actual root systems that Salisbury had excavated for the purpose. He published a number of such drawings in later books (Salisbury 1935, 1952)
[73] Oliver 1925.

view' of the vegetation types of the country, from the plant formations of coasts and estuaries up to the arctic-alpine types of the high hills of Scotland."[74] Smith exhibited further relief models at the Society's 1929 annual meeting, together with vegetation maps from the Scottish Pentland Hills, to illustrate a lecture on experimental methods. The following year, Thomas Woodhead also adopted the relief model as a display strategy, exhibiting both model and maps to illustrate ecological surveys of clough (a narrowly incised stream valley) woodlands in West Yorkshire. Woodhead took the method considerably further, making a series of 14 such models to demonstrate the development of vegetation and landscape over thousands of years.[75]

A 'bird's-eye view' became increasingly important in ecological survey work, from the early 1920s onwards. Following technical advances made in support of Allied operations during the First World War, ecologists became early adopters of new techniques for aerial photography. One Cambridge palaeobotanist and BES member, Hugh Hamshaw Thomas (1865-1962) had served with the Royal Flying Corps in Egypt, where he was placed in charge of aerial reconnaissance. The maps made by Thomas and his team for this work were the first compiled from aerial photographs and were widely recognised as decisive in the success of General Allenby's Sinai and Palestine Campaign. By 1920, Thomas was giving public lectures to the Royal Society of Arts on *Aircraft Photography in War and Peace*, focussing on the uses of aerial photography for vegetation surveys, in particular for widescale forest inventory.[76] At the BES annual meeting in 1921, Thomas gave a talk on aerial photography and vegetation mapping, showing examples of his war work in Palestine and Germany, but also from Blakeney Point, where he had persuaded the Cambridge University Aeronautical Department and the RAF Special Experimental Flight at Duxford to make three survey flights that year (Fig. 3.11).[77] In the same summer, Thomas led a society field excursion to Wicken Fen outside Cambridge, where he used aerial photographs, in the field, to guide his party around the different types of vegetation present on the site. Thereafter aerial photography was increasingly used for large scale inventory surveys, especially in colonial contexts. Further examples were periodically exhibited by Thomas and others at BES meetings and, along with

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[74] *J. Ecol.* 1915: 41; J. *Ecol.* 1929b: 184; Salisbury 1930: 185.
[75] See the following *Amateur associations* for further context on Woodhead's relief models
[76] Harris 1963; *Flight* 1962.
[77] Salisbury 1922: 260; Sheail 1987: 191; Adamson and Salisbury 1922: 254. The experimental nature of the Thomas's method was strikingly illustrated when a further flight in 1922 was forced to make an emergency landing on the shingle spit at Blakeney and the plane had to be dismantled and returned to base on the back of an RAF lorry.

other foreign expeditionary photographs, were enthusiastically received for "the vivid and fascinating glimpses of new types of vegetation they had given the Society."[78]

Fig. 3.11. J.C. Griffiths. *Part of the Salicornia-Pelvetia salt marsh behind the Headland at Blakeney Point. 1921.* BES Tansley Photographic Collection. GRI/2.

Ecologists seem to have been particularly open to the possibilities of photographic innovation for visualising their subjects, for new techniques of scientific record, and for making visual records of field experience. As we have already seen, at the BAAS in 1904, they showed a marked interest in the visual possibilities of motion pictures when Drina Scott showed her kammatograph sequences of plant movements. In addition to aerial and panoramic photographies, on the coast of Brittany in 1907, Frank Oliver enlisted the assistance of pioneers in colour photography for surveys of saltmarsh vegetation.[79] He also began to use repeat surveys, including detailed mapping and photographic records, to assess changes in the vegetation over time. Others took up the method in due course, but Oliver also combined this new photographic technique with his panoramic pictures to monitor the

[78] *J. Ecol.* 1925: 168; Salisbury 1931a: 226. A few examples were also published in the Society's journal, eg. Stamp 1925.

[79] See *Experiments in ecological surveying* in this thesis for further details on Oliver's Brittany work.

development of sand dune vegetation at Blakeney (Fig. 3.12).[80] Almost three decades later, at the 1933 BES summer meeting, Thomas Woodhead showed a number of infrared photographs, showing vegetation on the Pennine fringes, impressing his fellow ecologists with the "extraordinary wealth of detail in the distance, much of which it had not previously been possible to photograph at all."[81]

Photographic associations

As all these examples suggest, throughout the early decades of the 20th century, ecologists developed photographic methods as critical disciplinary tools, both in detailed ecological studies and in primary vegetation surveys. I discuss some of these developments in relation to ecological field methods in chapter 5. In the following paragraphs, I want to explore some of the related representational practices of ecology in more detail, to understand more clearly the capacities expected of photographs in the exchange of ecological knowledge, and how they might be distinguished from other kinds of botanical photography.

In the purely descriptive photography of primary survey, specific examples of photographic practice often suggest a common visual culture of the field, shared alike by ecologists, amateur naturalists and other botanists. Professional, academic botanists of the early 20th century, for example, did not wholly abandon 'the field' in favour of the lab and, like other field botanists, they commonly supplemented their collecting and observation with photographs. They sponsored foreign collecting expeditions, in return for specimens and propagules, for use in herbaria and laboratory experiments. Economic botanists, similarly, shared with naturalists and ecologists a highly visualised culture of fieldwork, frequently mediated through photography. Yet, the epistemic contrast between ecological images and other kinds of botanical photograph is apparent. Taxonomic botanists and their collectors

[80] Oliver does not seem to have published photographic sequences to illustrate vegetation development, despite relying upon photographs as a primary assessment tool. For further discussion on this methodological innovation, see *Experiments in ecological surveying* later in chapter 5 of this thesis. The technique was subsequently described in detail by E.P. Farrow and systematically applied by him in a series of experimental studies in grasslands and heaths in East Anglia (Farrow 1915a, 1915b, 1916, 1917a, 1917b). Other early examples of fixed-point or repeat photography for ecological monitoring, sometimes less systematically applied, can be found in Thompson 1922; *J. Ecol.* 1934: 323; *J. Ecol.* 1940: 253

[81] J. *Ecol.* 1933c: 220. Photographic William Abney had first registered infrared light on a photographic plate as early as 1880, but early photographic uses of infrared sensitive emulsions were restricted to studies of the solar spectrum. In 1910, Robert W. Wood made the first infrared landscape photographs, but it was not until the early 1930s that infrared film became widely available (Wood 1910; Clark 1939; Callender 2008).

Fig. 3.12. F.W. Oliver. *Young dunes arising on the shore, Blakeney Point. 1910 and 1914.* BES Tansley Photographic Collection. OLI/1/9-10.

were more interested in the discovery of new species, and in their requirements for propagation, than in vegetation associations or ecological process and this is evident in the photographic collections of numerous botanical explorers, in the archives at Kew Botanic Gardens and elsewhere. This alliance of taxonomic looking in the visual experience of botanical exploration is nowhere more apparent than in the travel diary and photographs of Arthur Hill who, as Director at Kew, Dean of King's College, Cambridge and a Fellow of the Linnean Society, embodied the institutional links of the botanical establishment.

Travelling in South America in 1902-03, Hill kept a detailed diary of his travels and botanizing. On the 4th December 1902, he was excited by the visual display awaiting him on a coastal ramble outside Coronel, Chile:

> We walked along the water's edge and got some Adiantum under a bush on a dry bank - the back of the frond covered by yellow wax - we then turned to the edge of the hills passing some plants of a white Oenethera - dwarf - not unlike O. Taxifolia. On the rocky hillside several plants of interest. A Bomarea was twining over the shrubs – with terminal umbels of a curious crimson claret colour marked with purple - a succulent pink Oxalis - a small Geranium - shrubs of a yellow Composite ?Senecio in full flower - forming masses of gold. Bushes of a very pretty pale mauve Calceolarea with open flowers like a little foxglove - spotted with purple spots & a little yellow at the base…"[82]

When he was not overwhelmed by the sensory experience of an exotic landscape, Hill was also active with his camera, keen to record species of particular interest. He could only convey the colour richness of such displays in words but, even in pictures, he singled out individual species as objects of special interest. His image of the cushion-forming montane plant *Azorella columnaris*, on the volcanic slopes of El Misti in Peru was typical (Fig. 3.13). Hill mounted the photograph, and many similar images, in an album with captions for species of particular interest. The subject species is always placed centrally and dominates the frame. The picture is clearly also intended to indicate something of the species' natural location, but its primary aim is to record the plant's habit and appearance, as a guide to future propagation. A shallow depth of field emphasises the individual plant at the expense of context. The presence of any other plants, the immediate setting and environmental conditions are registered only incidentally, except insofar as they might inform future propagation of the target species. The image strongly resembles the woodcut illustration of another montane species used by Anton Kerner in his *Natural History of Plants* in 1895 (see chapter 2, Fig. 2.2).

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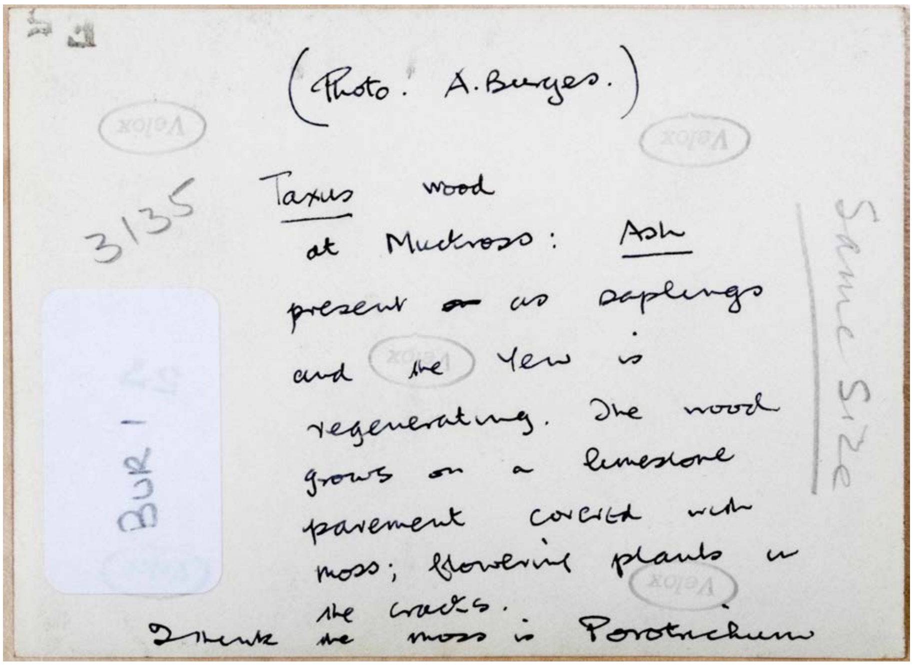
[82] Sir Arthur Hill Papers. Travel Diary: South America 1902-03. Royal Botanic Gardens, Kew. Kew/AWH/1/1

Fig. 3.13. Arthur Hill. *Azorella columnaris*, 1903. *Photograph Album of a Journey in Chile, Bolivia and Peru*. Sir Arthur Hill Papers, Kew/AWH/4/1.

Ecologist-photographers, by contrast, were concerned specifically *with* such context. Any number of photographs in the collections of ecological photographers might be shown to demonstrate this contrast with Hill's picture from El Misti. One such is a photograph from an Irish woodland, taken by Alan Burges in 1936 (Fig. 3.14 overleaf). The subject of this picture is not a single species but a complex association of biological and physical objects, regarded as a unity – an *ecological* object. This is confirmed on the reverse of the photograph, which carries a description detailing the primary constituents and structure of the vegetation, together with information on the site's geology. The picture confirms the visual basis for field practice in plant ecology and a continuity of photographic practice between ecologists and the parallel traditions of naturalist and academic botanist. But the shift in photographic subject is also significant. It indicates a challenge to the conceptual framework of 19th century botany, with its emphasis on species morphology and systematics, proposing in its place a science of complexity and relatedness. It is this tacit, relational knowledge that gives the image its content and makes it an *ecological* photograph.


(Photo. A. Burges.)

3135

Taxus wood at Muckross: Ash present ~~or~~ as saplings and the Yew is regenerating. The wood grows on a limestone pavement covered with moss; flowering plants in the cracks. I think the moss is Porotrichum

Same Size

BUR 1

Fig. 3.14. A. Burges. *Taxus wood at Muckross, Killarney*, 1936. BES Tansley Photographic Collection. BUR/1.

Such photographs were intended to provide a visual account of the ecological object, as it might be experienced in the field. They depicted habitats and plant associations, in support of the idea of a taxonomy of vegetation communities. They also described a range of other ecological processes or phenomena – such as vegetation succession, zonation or the influence of particular environmental factors. They supported the idea that such phenomena have a visible expression in field experience and that this expression can be captured, more or less unproblematically, by the camera. This is not to say that ecologists were careless photographers. Precision and technical competence in photographic practice were prized, just as in other instrumental methods of data collection and survey. In particular, camera type and size were considered important, to obtain appropriately scaled photographs. Technical control was required to ensure sharp focus and clear detail over a maximum possible depth of field, consistent with the field of attention, which was devoted to the wider habitat context, rather than any individual species.[83]

Fig. 3.15. Jean Massart. *Foulshaw Moss, 1911.* BES Tansley Photographic Collection. MAS/44.

In addition to such straightforwardly descriptive photographs, as we have seen, ecologists also explored the representational capacities of photography by exploring new formats and specialist camera technologies. In addition to panoramas and aerial photographs,

[83] See chapter 5, *Looking and counting: mathematical vision* for more on ecological precision and photographic methods.

experiments in colour and infrared, at least one ecologist attempted to incorporate stereographic photography into the visual work of ecology (Fig. 3.15). In all these examples, the prime concern of was to enhance the descriptive possibilities of photography in relation to the ecological subject. This required a high degree of technical control and mastery of some specialist photographic techniques. In common with most other scientific photographers, early ecologists maintained an uncritical conviction in the fidelity and descriptive power of the photograph in relation to their objects of study.

Photographic practice is not only a matter of representation, however, and although uncommon among ecologists, stereography articulates keenly both the visuality of ecological fieldwork, and the social character of related knowledge exchange, through practices of photographic viewing. Presumably, for Belgian ecologist-photographer Jean Massart, the stereograph offered an enhanced potential to describe vegetation, rendering its physiognomy with greater precision and clarity, in a visual experience closely analogous to that of encountering vegetation in the field. Stereographs require special viewing apparatus, however, and looking at stereographs is not the same as looking at ordinary photographs. It entails a different way of interacting with photographs, different methods of handling, and a different kind of viewing experience. This is not only a question of visual encounter with photographic space rendered in three-dimensions. The stereograph demands physical as well as visual engagement. It must be handled and inserted into a stereoscope for viewing, handling and raising the binocular instrument to one's eyes, covering part of the face and shielding vision from surrounding distractions. The experience is singular and sensory, private and personal. But stereoscopic viewing was also a deeply social experience. Stereographs were commonly viewed in company, in a shared activity, passed between friends, family, or colleagues and accompanied by talk, gesture and performance. In such circumstances, the photograph becomes embodied, embedded within social interaction, integral with acts of communication and shared visual knowledge. There is no evidence that Massart's stereographs were viewed using a stereoscope, at meetings of the BVC or at BES conversaziones.[84] More likely they were viewed as flat prints, but the stereograph and its

[84] Massart sent both conventional photographs and stereographs to his British ecologist-colleagues. The circulation of stereographs does not itself imply that special viewing apparatus was available to their recipients. I have found no other ecologist who practice stereography and it is likely that Massart's British correspondents treated his stereographs in the same way as other kinds of photographs. Similarly, although other ecologists used Massart's stereographic images for print illustration, they only ever appeared as single images. The same need for special viewing apparatus

related viewing practices demonstrate a combination of subjective sensory engagement and the social exchange of shared experience. This combination is present in almost all acts of photographic viewing outside the private spaces of reading. Like the photographs and talk shared by members of the BVC, stereographic viewing practice reveals the capacity of all photographs to stand as proxies for ecological field observation and knowledge.

In contrast to photographs of single plants, or laboratory lab images of botanical specimens and microscopic sections, descriptive ecological photographs are also locational. As I have already suggested in connection with the Smith brothers' vegetation surveys, the specificity of place indicated by a descriptive ecological photograph is important, because it corroborates both a concrete instance of the ecological object, and its scientific witnessing by the ecologist-photographer.[85] However, ecologists were insistent that biologists must seek to understand not only the distribution of species and plant associations, but also the physiological basis for ecological adaptation and change, in response to particular site conditions.[86] Detailed investigations of the ecology of individual species, both in the field and in the lab, were also documented by photographic means. The resulting photographs were not merely records of the work, however, though they were important for that too; they were also essential analytical components of ecological investigation (Fig. 3.16 overleaf).

Ostensibly, the resulting photographs of individual plants, often appear like those of the taxonomic botanist. Richard Yapp's photograph of a bladderwort, for example, resembles an incomplete herbarium specimen, lacking only the addition of fruit and appropriate labelling. It shares with the herbarium specimen an apparent objectivity, derived from its highly stylised presentation. But this is no 'type' specimen. The *ecological* specimen-photograph describes a particular object — this plant and no other. Here, the mechanical objectivity of the photograph, so problematic for atlas makers seeking images that will 'stand in for' a whole species, is an asset. For the atlas maker, a single photograph is too specific and too inclusive, liable to foreground idiosyncratic variations in form, at the expense of shared characteristics by which a type or species may be recognised and defined.[87] Yapp's plant was grown and

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obviously made stereographs unsuitable for conventional publication in journals or books, which require two-dimensional images for print reproduction.

[85] See chapter 2, *Mapping the field: the beginnings of British vegetation survey*.

[86] Tansley (1904), distinguished between descriptive and analytical phases of ecological investigation and regarded experimental physiology as central to the development of analytical ecological science.

[87] Daston and Galison (2007) have written at length about the use of images in taxonomic atlases and the problems of photography's mechanical objectivity in depicting 'type' specimens in the late 19th and early 20th century. The mechanical objectivity of photographs was increasingly seen by atlas

Fig. 3.16. R.H. Yapp. *Plant forms in water.* Undated. BES Tansley Photographic Collection. YAP/7, 1, 2, 15.

(Top left) *Utricularia (bladderwort), showing habit in water.*
(Top right) *Sagittaria sagittifolia in still water. Sagittate leaves.* YAP/1.
(Bottom left) *Sagittaria sagittifolia in running water, leaves mostly linear.* YAP/2.
(Bottom right) *Sagittaria sagittifolia in water, showing young plants with linear and older with both forms of leaves. Also a few intermediate forms.* YAP/15.

photographed in an aquarium, specifically to investigate its morphology as a response to environmental conditions, not for its capacity to represent or define an entire species. Similarly, pictured in its natural setting, Yapp's photographs of *Sagittaria* might elsewhere be

makers as insufficient to the task of creating reliable guides to recognisable forms or families of objects, which required not only accurate depiction but 'trained judgment' to discriminate significant difference from aberrant variation.

taken as the straightforward plant portraits of a floristic botanist. In fact, Yapp was investigating the growth form of plants in response to habitat conditions and the variations evident within plant communities, and even between plants of the same species — in this case, divergent leaf-forms in different aquatic habitats.[88] These photographs were not simple plant portraits, they were demonstrations of ecological adaptation.

Arthur Hill's view of the function of botanical photographs was very different. When he spoke at the Imperial Botanical Conference in 1924, by which time he had risen to the position of Director at Kew Gardens, he suggested "the desirability of instituting a collection of really good photographs of type plants which could be exchanged between various botanical centres of the Empire...Similarly, it would, I am sure, be of great advantage to the colonial herbaria if photographs of classical type specimens could be provided from Kew or from the British Museum, or from herbaria from the Continent."[89] Hill's remarks suggest that the BAAS Botanical Photographs Collection was already long forgotten. But the point here is that, for Hill and other systematic botanists, photographs provided examples of the species type, not individual plants. Botanical specimens and photographs were both of value as proxies for an ideal species, for which the authenticating point of reference remained the herbarium, not specific instances of plants in the field. Yapp's pictures tied laboratory work back to the field, as the authentic ground of ecological insight.

Ecologists insisted that their studies, including experimental work, should as far as possible be conducted in the field, if lab-based insights were to be transformed into ecological understanding. The analytical photograph also had a role in the field, therefore, documenting change in response to environmental influence. This dual function was evident in ecological photography as early as 1897, in an unpublished study conducted by Arthur Tansley, in which he combined photographic observations of bracken fronds from different 'fixed light positions' in a woodland. In a series of paired images, he recorded the character of the habitat in different locations and the contrasting leaf-forms arising in response to varying natural light conditions (Fig. 3.17 overleaf). In studies like these, photography combined field evidence with laboratory observation. The resulting pictures function as illustration but also as evidence, visual analogues but also scientific data.

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[88] Yapp summarised some of these issues in his Presidential address to the BES in 1922 (Yapp 1922a).
[89] Hill 1925: 202-3

Fig 3.17. A.G. Tansley. *Bracken, fixed light position 3. Redlands Wood, 1897.* BES Tansley Photographic Collection. TAN/1/2 & 14.

Fig. 3.18. H. Godwin. *Automatic water-level recorder, Wicken Fen, 1928.* BES Tansley Photographic Collection. GOD/1.

Harry Godwin's picture of an automatic water-level recorder at Wicken Fen (Fig. 3.18), near Cambridge, illustrates a third category of ecological photograph – the disciplinary photograph. In this example, Godwin photographed the field instrumentation installed for his study of water levels in the wetland vegetation of Wicken Fen near Cambridge. Ecologists introduced a great variety of instruments to their field studies, mostly for measuring environmental parameters in relation to vegetation development. Godwin took a number of pictures of this kind and published them in accounts of the ecological methods and results from his studies. Images like this are by no means unique to ecology, but they record science at work, documenting the disciplinary practices of ecology, its methods, its instrumentation and scientific activity. Their immediate function was documentary, to describe the methods applied within an individual study. But they also fulfilled functions for disciplinary regulation and for professional recognition. They documented methods as a mode of instruction to other ecologists, in order that those methods could be applied by others, and as a contribution to the development and standardisation of ecological techniques. Equally importantly, such pictures showed ecologists doing work which was visibly scientific, addressing potential criticisms of the new science from established scientific quarters.

Photography in all these examples served as illustration and evidence for ecological objects and their scientific study, but ecologists expressed more than purely scientific values through photography. Belgian ecologist and stereographer Jean Massart, for example, was also a very accomplished landscape photographer. He combined botanical and ecological knowledge with high level of technical skill in photography and a strong aesthetic sensibility. Richard Yapp exhibited prints at Royal Photographic Society exhibitions. His photographs in the Tansley Collection consist entirely of toned prints. Print-toning of this kind was commonly applied by photographers for aesthetic reasons, to enhance tonal range and to achieve a range of colour tints. Toning was unusual among ecologist-photographers, most of whom were less sophisticated image makers than Yapp. Toning also commonly applied to improve the archival longevity of photographic prints, but a concern for aesthetic effect is evident even in Yapp's most analytical photographs. Aesthetic qualities were certainly valued by ecological audiences. Photographs were frequently commended at BES meetings for their aesthetic appeal as well as for technical excellence.[90] This combination of scientific and aesthetic values expressed both a disciplinary commitment to ecology as scientific practice, and a shared

[90] *J. Ecol.* 1924: 329; 1925: 169, 173; 1929a: 186; 1935: 256.

emotional and ethical commitment to the objects and natural places where that practice occurred.

Outdoor associations

Equally importantly for a narrative of the expanding disciplinary field of ecology, ecologists also photographed one another, especially *in* the field. Just as the visual discourses of BVC meetings were extended and enriched as it transformed into the BES, so the Society perpetuated and enlarged also upon the Committee's excursionary practices. On April 13 1913, the very next day after constituting themselves as a Society, the members' first activity was to take a joint excursion to Pevensey on the Sussex coast, to view and discuss the ecology of its shingle beaches. Thereafter, every annual and summer meeting entailed field expeditions, often occupying considerably more time than indoor meetings. The Society was soon running two or more general meetings each year, an indoor conference and soirée in the winter and at least one summer meeting which was focussed on site visits and excursions. Summer excursions were less well attended than annual winter meetings but were considerably lengthier. Between two and five days was the norm, but trips of 5-7 days were not uncommon. In 1920, excursions were organised for five days to Blakeney in May *and* a further 7 days in August to the Lake District, as well as a visit to Epping Forest during the annual winter meeting. In 1936, the summer excursion to Ireland lasted 10 days. With excursions to the heaths and woodlands of the New Forest, Pennine uplands and Scottish mountains, East Anglian fens, Welsh oakwoods and mires, to coastal habitats from Sussex and Norfolk, Lancashire and southwest Ireland, the society sought to cover the full range of British habitats and vegetation. Evening indoor meetings during such expeditions were mini-conversaziones, populated by sociable conversation and photographically illustrated talks on local features of ecological interest.[91]

The importance of the field excursion, and of its photographic record, was best illustrated in the first International Phytogeographical Excursion (IPE), which took place in Britain in 1911. For the first British ecologists, this was the crowning achievement of excursionary practice and a crucial contribution to the emergence of a national and international community of practising ecologists. It was also richly recorded in the photographs of its participants. A few years into the life of the BVC, in 1908, Arthur Tansley had joined a tour of Switzerland, led by Swiss ecologist Professor Carl Schröter. An influential figure in European

[91] Annual Meeting Reports of the BES, *Journal of Ecology* 1913-1939.

botany and ecology, another member of the BVC, Thomas Woodhead, had studied under Schröter in Zurich. Tansley was especially impressed by the benefit of making contacts among other, non-British ecologists, by the value of examining vegetation "under the guidance of native botanists who had studied it...[and]...the stimulating effects of the comments of foreign visitors."[92] It was, he said, "in all respects a model of what an international excursion should be," and he returned full of enthusiasm for organising something similar in Britain. Later the same year, a week-long BVC expedition to the west of Ireland confirmed his conviction in the value of such excursions which, he decided were essential for the evolving study of vegetation, and much more so than for other kinds of botany. "While the student of the distribution of species can depend more or less on herbaria and on floras," he wrote later, "...the student of the distribution, structure, relationships and development of plant-communities has to depend upon published descriptions and photographs of vegetation, which, even at the best, do not convey to him an idea of the phenomena involved in any way comparable with that which he can obtain on the spot, especially with the assistance of botanists who have actually studied the vegetation in question."[93]

Tansley's remarks indicate the important place of descriptive, photographic accounts in communicating the idea and character of plant communities, whilst also reasserting the primacy of personal and collaborative field experience. Descriptive accounts and photographs were essential tools for the wider dissemination of ecological insights, but they were no substitute for direct observation, in the field, seeing for oneself and seeing together. Emphasising the value of field guidance from 'botanists who have actually studied the vegetation in question', Tansley recognised the importance of distinctive local knowledge and expertise, but also the need for training in good ecological judgment. Helping others to look and see in the right way, an experienced guide could assist others to make sound ecological observations. There is an element of disciplinary regulation here, in which correct observation is authorised by experienced vegetation workers, but also of collaboration and the collegial exchange of knowledge with other excursionists. Ecological knowledge was co-constructed through talk and right seeing.

These were the central purposes of the proposed IPE, for which Tansley obtained the support of other BVC members at the end of 1908. Schröter's model Swiss expedition had

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[92] Tansley 1947: 134.
[93] Tansley 1911: 273.

lasted eleven days but Tansley's plan was on a much grander scale. It took until the following December to establish an invitation list and agree a date for August 1911. Tansley and the other members of the BVC used the intervening time to prepare an exhaustive account of British vegetation types and their ecological study to date. The resulting text, copiously illustrated with photographs, ran to over 400 pages and was published as a bound volume, with copies distributed to each of the excursionists before their tour.[94] In the event, the tour lasted four weeks, beginning with two days of social events in and around Cambridge, to allow participants to get to know one another. The party then travelled together to Norfolk, north to the Peak District and the Pennines, the Lancashire coast and Lake District, into Scotland as far as Aviemore, then to the west of Ireland, and back via Cornwall to an additional week of meetings and local excursions at the BAAS meeting in Portsmouth. It was an itinerary that took in all the main sites of study investigated by British ecologists up to that point. With only 15 invited guests, and just 11 finally able to attend, the expedition group was not large but included most of the key European and North American figures in early ecology, all Professors or University lecturers in botany.[95]

The Tansley Photographic Collection includes a rich visual record of the 1911 IPE. Many of the participants carried cameras with them to record their experience and the vegetation they expected to witness on their tour.[96] The resulting vegetation photographs served the same purposes here as elsewhere, as observational records and as tools for thinking and talking about plants and plant communities. More importantly during such excursions, however, an

[94] Tansley *et al* 1911a The volume was also supplemented by 32 pages of *Descriptive Notes* in the form of a soft-bound pamphlet, providing a detailed guide to the topography, geology and vegetation excursionists could expect to encounter on their route around Britain (Tansley *et al* 1911b, CUL/TP/D.7).

[95] In fact the party was always larger than this because Tansley was present throughout, along with prominent botanists George Claridge Druce, who Tansley had invited for his was unparalleled knowledge of the British flora. At every stage, the party was further supplemented by experts on local vegetation - anything from 3 -11 additional participants. The foreign members of the group included, Frederic Clements and Henry Cowles from the USA, together with their wives (Edith Clements was also a trained botanist); Carl Schröter was joined from Zurich by his colleague Dr. Eduard Rübel; Oscar Drude and Paul Graebner came from Germany, Carl Lindman from Sweden and Jean Massart from Belgium. Carl Ostenfeld attended from Denmark but his compatriot Eugene Warming and another key early influence on British ecology, Charles Flahault, were both obliged to pull out at the last moment.

[96] The Tansley Photographic Collection includes over 200 surviving prints from foreign participants of the 1911 IPE. The discontinuous numbering of some of the prints suggests that the original number was considerably higher. The most active photographers included Edith Clements (32 surviving of a possible 39) and Elizabeth Cowles (67 surviving of 161), both wives of leading American ecologists Frederic Clements and Henry Cowles respectively. Swiss ecologist Eduard Rübel contributed 20 prints, with a further 100 by Belgian ecologist Jean Massart (many of the latter being stereographs) Sheail (Unpubl.).

ecologist's camera was as likely to be trained on fellow ecologists and botanists as plants or their habitats. The resulting photographs are not scientific, in the sense that they have no direct reference point in the conduct of scientific work, but the events and activities they record reveal something of the ways ecologists moved through a landscape, the ways in which they looked at what they found, and the ways they looked at one another. Photographic documentation of field excursions was not unique to ecologists. Parallel practices can be found documenting naturalists' excursions, geologists' outings and the social and expeditionary aspects of botanical explorations, such as those of Arthur Hill.

Fig. 3.19. Jean Massart. *International Phytogeographic Excursion, 1911.*
BES Tansley Photographic Collection. MAS/86.

Most commonly, excursionary photographs of this kind took the form of posed group portraits, recording who was present, often together with details of equipment and logistical arrangements for the expedition. Unnamed ancillary individuals also commonly appear in such photographs, their critical roles and interactions with official excursionists rarely acknowledged or otherwise recorded. A photograph by Belgian ecologist Jean Massart, depicting the assembled members of the 1911 IPE is almost certainly the first instance of a group portrait of ecologists (Fig. 3.19). Not only did this image record those present at the time, it stood as the first self-conscious statement of a group of individuals determined to present themselves to the scientific world as ecologists. Massart himself was no stranger to organising and leading excursions, and was especially active in their photographic documentation. At home in Belgium, regularly gave 'walking lectures' (conférences-promenades) and 'excursions-scientifiques', to students and others. In 1910, he arranged and led a series of excursions for the International Botanical Congress which met in Brussels in May. His account for the conference proceedings extended to two and a half pages of text, with 32 half-page photographs recording the vegetation, habitats and excursioners. He also presented every conference delegate with a copy of his 2-volume 'outline' of the vegetation types of Belgium, the second volume of which comprised 446 collotype prints, almost all from his own photographs, just over half of them stereographs.[97]

By 1911, the use of handheld cameras was widespread and made possible new kinds of visual record in excursionary photography. It became much easier to record the significant features of field study, and the significant moments and places of ecological practice. Most importantly, casual photographic snapping with a hand camera made it possible to register many *more* moments that would not previously have been recorded but which offer instructive glimpses of excursionary field practice. Elizabeth Cowles' photograph (Fig. 3.20), for example, of excursionists queueing to ascend a ladder, to view the shingle beach habitat at Blakeney, reveals the individual and collective demeanour of participants. It also demonstrates the intense visuality of ecological field experience as those present assisted one another to a shared view of vegetation.

Another richly suggestive image reveals the range of activities engaged in by botanical and ecological excursionists. Again from Blakeney, the image shows the Swiss Professor Schröter, a vasculum hanging on his shoulder, specimen in hand, consulting a flora or his own notebook. Nearby, Arthur Tansley (in the straw boater) examines the details of the shingle habitat, two other excursionists engage in intense discussion, whilst another seems to raise a hand to his eyes to shield the long view across the coastal plain (Fig. 3.21).

[97] Denaeyer-De Smet *et al* 2006; Massart 1910a, 1910b; *New Phytologist* 1910.

Fig. 3.20. Elizabeth Cowles. *International Phytogeographic Excursion, 1911.* BES Tansley Photographic Collection. COW/7.

Fig. 3.21. Elizabeth Cowles. *International Phytogeographic Excursion, 1911.* BES Tansley Photographic Collection. COW/9.

Finally, another of Jean Massart's stereographs encapsulates not only the social significance of excursionary photography but its all-pervasive currency among participants (Fig. 3.22). It also shows ecologists engaging with a range of photographic practices and technologies, as Massart trains his stereo view on Frederic Clements and his tripod-mounted field camera, both of them sharing in Elizabeth Cowles' hand-held portrait of Arthur Tansley and Marietta Pallis. Few photographs offer so rich an expression of the photographic moment and its embedded place in the social practices of science.

Fig. 3.22. Jean Massart*. International Phytogeographic Excursion, 1911.* BES Tansley Photographic Collection. MAS/15.

These social photographs of ecology were widely circulated between IPE participants, in 1911 and following subsequent IPE excursions, after they returned home. Through their photographs, participants continued to memorialise the places and events of the IPE experience, and to cement the relationships they formed during the excursion, for many decades. The photographs documented the social practices of ecologists, encouraging them to arrange similar experiences for themselves elsewhere. They bolstered a sense of professional and disciplinary unity, realising and reinforcing an imagined community of professional ecologists, even before it had a clear identity or presence in the scientific world. In such photographs, botanists began to *see* themselves as ecologists.

By any measure, and especially by the universal acclaim of its participants, the IPE was a tremendous success. Whilst the excursion was still underway, the American representatives, Frederic Clements and Henry Cowles, declared their intention to repeat the experience in the USA. They did so in 1913, organising a mammoth expedition that took two months to complete. The IPE became established as a standing organisation, under the auspices of the Rübel Institute in Zurich, arranging further expeditions through the Alps in 1923, Scandinavia in 1925, Czechoslovakia and Poland in 1928, Romania in 1931, Italy in 1934, and Morocco, in 1936. The nineteenth and final IPE took place in Poland in 1989. As far as Tansley was concerned, the IPE was the final great achievement of the BVC.[98] The IPE, he said, "did a great deal to increase mutual understanding between the phytogeographers and ecologists of different countries and many personal friendships were formed and cemented."[99] It also gave significant impetus to the idea of a British Ecological Society.

The socially and epistemologically cohesive effects of the IPE for ecologists were also strongly attested in private correspondence, and in print, by numerous participants. Several of the them contributed notes and reviews of the excursion for Tansley to publish in *New Phytologist.*[100] Henry Cowles expressed gratitude and "admiration for the splendid organisation of the British plant geographers". He predicted that this first IPE would prove to be of far-reaching importance and emphasised a close link between the sociability of the excursion and its beneficial effects on ecological understanding. "I have felt that the chief benefit to me has been the opportunity of living for a month in intimate relationship with my phytogeographic colleagues of other countries," he wrote, "of knowing them from many points of view, and thus of coming to feel that they are friends, as well as fellow scientists…Close companionship has made us more sympathetic with opposing viewpoints, and more ready to see at least some truth in views we thought were wholly wrong…It is from such intimate acquaintanceship among the workers and, perhaps, only thus that we may hope for constructive advances in securing uniformity of terms and methods." Cowles also wrote a note for the American botany magazine *Plant World*, echoing his own appreciation that "the phytogeographers who met in England in 1911 now know one another, and will be able henceforth to understand and appreciate far better the writings from one another's pens."[101] Frederic Clements wrote to Tansley more than once, expressing pleasure at the excursion as

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[98] Tansley 1913a: 1.
[99] Tansley 1947: 135.
[100] Cowles *et al* 1912: 25-28.
[101] Cowles 1912: 48.

"an outstanding experience, perhaps the most unique experience botanically that many of us will have." The excursion had done Tansley great credit, he wrote, both personally and as "the moving spirit" of the BVC.[102] This effusion of positive commentary testifies to the lasting impact the first IPE had on the minds and hearts of its participants. Even years later, after her husband's death, Edith Clements wrote to Tansley in 1947, remembering "the many pleasurable experiences when we were abroad in 1911. They are vivid memories and among the pleasantest of my life."[103] The vividness of those memories, and the effectiveness of the IPE in building a community of early ecologists was in no small part due to the uses of photography. Frederic Clements expressed a common enthusiasm for this kind of photographic memorialising when he wrote to Tansley, shortly after the excursion, reporting that "our films of the summer have just been developed and they bring home to us very forcefully the great pleasure and profit of the British journey."[104] In the field, and in subsequent memorialisation, the taking and sharing of photographs was an active force in the formation of social and disciplinary ties. For excursion participants, looking at each other, both during and after the event, was more important for developing the social community of ecology than any number of photographs of vegetation.

Amateur associations

National and international initiatives to promote ecological work, forging new associations through congresses and conferences, and founding new institutional frameworks for ecology through the resulting social and disciplinary networks; all these were all important in establishing British ecology. In all these settings, visual methods were vital to the making and performance of ecological knowledge, both in the field and in the many indoor spaces of institutional science. At least as important as the first ecological stirrings at the BAAS, however, or national initiatives for vegetation survey, were the established networks of amateur naturalists into which ecologists were already integrated. Despite the desire of ecologists for disciplinary recognition within the sphere of professional academic botany, in important respects ecology had more persuasive links with field natural history, whose institutions and practitioners were overwhelmingly dominated by amateurs.[105] Most members

[102] Clements to Tansley Nov 17 1911; Dec 20 1911. CUL/TP/H.27
[103] Clements (Edith) to Tansley July 15 1947. CUL/TP/H.32
[104] Clements to Tansley Nov 17 1911. CUL/TP/H.27
[105] For some, especially in the USA, ecology was the 'new natural history', whilst Charles Elton, Britain's first prominent animal ecologist was clear that "ecology is a new name for a very old subject. It simply means scientific natural history." (Elton 1927: 1). Robert Kohler has reviewed the rise of the 'new

of the BVC retained associations with amateur naturalists' societies long after the committee has ceded its activities to the newly formed British Ecological Society in 1913. William Smith, for example, who left Yorkshire for his native Scotland in 1908, became very active in the Edinburgh Botanical Society, taking on council membership and vice-presidency from 1912. Edward Salisbury maintained a long relationship with the Hertfordshire Natural History Society, and with the Norfolk and Norwich Naturalists' Society, reflecting the locations of his most important ecological work. As Arthur Tansley had pointed out in 1902, and again in 1904, the amateur community offered a largely untapped resource for undertaking comprehensive and systematic surveys.[106] Nowhere was ecological engagement with this community more energetically and decisively pursued than in Yorkshire, where William Smith was lecturer in botany at the University at Leeds from 1897 until 1908. Smith's importance in the national emergence of British ecology is clear, and well recognised by historians of ecology.[107] Arguably, however, his most significant contribution came not in the pioneering survey work which he and his brother initiated, but through his engagement with local, amateur naturalists. His secretarial and coordinating role within the BVC was critical in promoting ecological work within a professional and academic context. But his influence was most acute in the enthusiasm he generated in others for such work, especially those outside the professional botanical community. That influence was further extended through those others, who not only took up the work but transmitted Smith's enthusiasm to another 'generation' of ecologist amateurs. The means by which they did so once again underscored the visual basis for ecological work, and the central place of photography, along with other visual and material practices, in the culture of field natural history in general.

Smith was an inspirational teacher and "kindled a lasting interest in botanical survey and ecology" in those who came into contact with his enthusiasm.[108] In addition to his duties as a teacher and laboratory researcher, and his own extensive vegetation surveys, he also joined the Yorkshire Naturalists' Union, where he became a key figure in stimulating and directing new botanical research along ecological lines. In his survey work, he enlisted the practical

natural history' in the USA in the first decade of the 20th century, in his study of *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology* (Kohler 2002a: Ch.2).

[106] Tansley 1904a: 198. "One of the most crying examples of the waste of good work and sound knowledge in the field of modern botany," Tansley said, "is the utilisation of the work of the local botanist and the local field club….The extensive co-operation and co-ordination of workers…would probably lead to a very striking development of the whole subject."

[107] Woodhead 1906, 1923, 1929; Tansley 1947; Salisbury 1964; Lowe 1982; Sheail 1987; Ayres 2012.

[108] Woodhead and Tansley 1929: 170.

support of his students, many of whom also became active in the Union and its affiliated local natural history societies. In 1902, as Smith and his students were conducting their surveys of Yorkshire vegetation, he persuaded a number of his amateur colleagues that the Union should establish a Botanical Survey Committee to promote and coordinate further work of a similar kind. One historian of ecology has marked this initiative as the beginning of organized and systematic research in British ecology.[109] In an effort to enlist more amateur workers, Smith wrote a paper, circulated by the Union among its affiliated Societies and more widely, on 'Botanical Survey for Local Naturalists' Societies.'[110] In it, he addressed head-on the difficulties faced by ecologists in persuading field botanists to the take up the new methods for vegetation survey. "A local botanist, however willing and able he may be to assist, has a certain difficulty in grasping the method," he wrote. So he outlined again the fundamental concepts and methods that he and his students were already applying in Yorkshire and attempted once more to overcome the taxonomic predilections of most of his readers. What he now proposed, he told them, was a method that would move beyond simple species lists to the description of plant associations, a method by which "a picture of the vegetation of the selected area is conveyed to the botanist. By placing together the various plant-associations one may reproduce the whole vegetation of a parish, a river-basin, or a country." Smith was asking his amateur colleagues to abandon their customary understanding of their local flora, to build a different kind of picture, based on the direct appearance of the vegetated landscape, through "exact observation and the reproduction of what the eye perceives." In practical terms, as we have already seen, this meant observing and reproducing vegetation by means of maps and photographs.

Photography was already prominent in the activities of many YNU members, as a method of scientific record and data collection, and of documenting personal and group experience, both social and scientific. As early as 1891, the YNU was proud of its photographic contributions to scientific natural history, especially in relation to the geological photographs scheme and other aspects of photographic survey recommended by the BAAS.[111] Individual members extolled the virtues of photographic natural history, from the study of bird behaviour and the environmental responses of plants, to the use of photographs for general

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[109] Lowe 1982

[110] Smith 1903. Smith's paper was initially published in *The Naturalist*, the journal of the Yorkshire Naturalists' Union, in January 1903. It was subsequently re-issued as a separate pamphlet, however, for circulation to other local naturalists' and botanical societies.

[111] Bedford 1891: 69. Godfrey Bingley, a major contributor to the BAAS Geological Photographs Scheme, and to photographic surveys more generally, was also a member of the YNU.

education in life sciences. "What could be more suitable for museum decoration than a fine series of Nature photographs?"[112] Many amateur naturalists relied on photography to record everything from geological formations to hornets and plant portraits. Huddersfield mycologist Alfred Clarke, to take just one example, was rarely without his camera, and built a considerable personal collection of photographs of fungi. Ornithological photography was particularly popular, and some YNU zoologists, such as Riley Fortune and Oxley Grabham, became widely noted as pioneering natural history photographers. These naturalist photographers took photographs for their own records, and also to share their field experience with others in illustrated evening lectures or in publications. Others, like John W. Farrah from Harrogate, acted as unofficial photographic recorders for group field-excursions, where they were as likely to turn the camera on their fellow naturalists as on their objects of study. Photographs were commonly displayed at society meetings, exhibitions and even during excursions. YNU members showed their photographs more widely too, giving lectures to other societies and in other exhibitions, including the annual exhibitions of the Royal Photographic Society where, in 1909, six Yorkshire Naturalists were included in the scientific section of the show.[113]

Not all members approved of so much photography. Seth Mosley, for one, took exception to what he called 'nest-poking', or photographing birds' nests. Nests were being stolen for the purposes of photography, he complained, and even when photographed *in situ*, the 'unwarrantable intrusion' by large numbers of naturalists resulted in trampling and disturbance, and birds driven away from their nests. "And what good is the photograph when taken?... We know already far more about a nightingale's nest than any photograph can tell us."[114] In public display as well as in the field, the value of photography could be questioned. Thomas Sheppard, a geologist and museum curator from Hull, warned that the widespread use of photography and the magic lantern was partly responsible for a decline in the quality of public lectures in science. But he recognised the appeal of the 'popular lantern lecture' to

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[112] Thornley 1903: 120.

[113] Naturalist 1909: 446. Alfred Clarke was one of the founders of the British Mycological Society in 1896. His photographic collection is now held at the Tolson Memorial Museum, Huddersfield. Riley Fortune and Oxley Grabham were both celebrated early wildlife photographers. Fortune was a founding member of the Zoological Photographic Club, established in 1899. Grabham was curator of York Museum from 1905 and also documented the Museum collection photographically and the local rural community. He published a popular photographically illustrated book on British mammals.

[114] Mosley 1906: 22.

members and was resigned to its inevitability.[115] Despite such misgivings, these very interventions indicate the near-ubiquitous hold of photography on the practices of late 19th and early 20th century natural history.

In the midst of this ubiquity, most amateur naturalists would not readily have recognised or named an 'ecological' photograph as such and few conscious links between photography and ecology can be traced in the records and journals of natural history societies. Nevertheless, active Yorkshire ecologists spoke and exhibited frequently in lectures and conversaziones, and made use of the same photographic strategies of record and knowledge exchange as their more conventional naturalist colleagues. William Smith was prominent among such speakers, both at the YNU and its affiliated societies. In one of the earliest British statements of basic ecological principles, Smith spoke to the Huddersfield Naturalists' and Photographic Society in 1899 on "two great problems in plant life". With the assistance of 'numerous lantern slides' and plant specimens, he laid before this local naturalist audience a way of thinking that would have been wholly new to most of them. He described the principles of plant communities and associations, of plant adaptation in relation to environmental factors, and the resulting zonation of plants and vegetation types along an environmental gradient. He referred to Warming's *Plantesnamfund* as "the standard work on plant-life in relation to environment." He returned the following year, hoping once again to encourage local naturalists to take up vegetation survey work, with an "Introduction to the Study of Local Plant Associations," and again in 1901 with a lecture on " Yorkshire Plant Associations", explaining again the ecological principles of vegetation and its survey.[116]

One or two Yorkshire ecologists were also accomplished photographers and made systematic photographic records to accompany their ecological investigations. Frank Elgee was one such. His investigation of 400 square miles of moorland in North Yorkshire stands as the first integrated ecological study of an entire British landscape, encompassing geology, soils, vegetation, flora and fauna, as well as the archaeology of human occupation. He undoubtedly acquired his ecological outlook from his association with the YNU, where he

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[115] Sheppard 1903a: 218. Sheppard clearly had mixed views on the value of photography. At the Corresponding Societies Conference in 1906, he spoke up in support of proposals from W. Jerome Harrison for county photographic surveys and was among those recommended for appointment to a committee for these purposes (BAAS 1907: 65-66). He certainly found ample place for photography in his own publications. His *Geological Rambles in East Yorkshire* (Sheppard 1903b) was illustrated with over 50 photographs, mostly by Leeds photographer Godfrey Bingley.

[116] HNPS Monthly Circulars, Oct. 1899, Nov. 1900; HNPS Annual Report 1902: 9. HNPS Collection, Huddersfield Local Studies Library.

became a member of the Botanical Survey Committee set up by William Smith.[117] But Elgee had a passion also for photographic record, which became an essential component in all his ecological and archaeological work. Other ecologists were not so proficient as photographers. But even when they could not reliably make their own, they were more dedicated than most in the pursuit of photographic records. William Smith was no photographer; instead, he relied on photographs supplied by others to provide the essential photographic components of his published work on vegetation surveys, and for his lantern lectures. Many of the pictures included in his vegetation surveys were provided by another keen ecological photographer. William Crump, whose collection of vegetation photographs we have already encountered, was one of his chief suppliers. Whilst Crump undertook no systematic vegetation surveys on his own account, he assisted both Smith and Smith's student, his friend Charles Moss, and set himself the task of photographing vegetation types throughout Britain.[118] Similar ecological-photographic collaborations were stimulated elsewhere within the YNU, amongst others captured by Smith' enthusiasm or that of his students. The most striking such partnership arose informally in one of the YNU's affiliated local societies, where the associations between photography and natural history had already become particularly close.

The long-established Huddersfield Naturalists' Society, which was formally constituted in 1850, had combined with local photographers in 1892 to form a joint Naturalists' and Photographic Society (HNPS). This had the effect of bringing together previously distinct groups of practitioners who began to cooperate and combine activities. It also recognised and promoted the coincidence of the two forms of practice in individual workers. The resulting intersections between photography, amateur natural history and ecology, gave an impetus to ecological work in Huddersfield that was absent in most other natural history societies. At the centre of it all was one of William Smith's most able and original students, a local biology teacher named Thomas Woodhead. Woodhead, was a perfect hybrid between professional botanist, ecologist and amateur naturalist, and also sat at the intersection of local, national and international networks of affiliation in natural history and ecology. From 1895, he taught

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[117] Elgee 1912; Woodhead 1910: 61-2. At the time, both Elgee and Smith were undertaking complementary surveys in Elgee's home country, the Cleveland Hills of North Yorkshire, south of Middlesborough, where Elgee worked as a curator for the Dorman Memorial Museum.

[118] A local schoolmaster, editor of the Halifax Naturalist and co-author of a Flora of Halifax (Crump and Crosland 1904), Crump's was the first local flora to attempt an ecological account of the district's plant associations and habitats. He accompanied Smith and Moss as photographer in vegetation surveys across Yorkshire and collaborated with Moss, surveying and photographing for monographs on the vegetation of the Peak District and Somerset.

biology at the Huddersfield Technical College but managed also to undertake summer studies over several years, initially at the University of Bonn, then at the Royal College of Science in London. In 1900, he studied briefly in the University of Cambridge botany school, where he was offered a post. Lacking private means, and perhaps the inclination, he declined the offer and remained in Huddersfield. He became a Fellow of the Linnean Society in 1899, and was a founding member of the BVC and its successor the BES, for which he went on to serve as President in 1926-27. In 1905, he took extended study leave to work with the internationally renowned ecological botanist Carl Schröter in Zürich, where he was awarded a PhD. His qualifying research comprised an intensive study of the ecology of woodland plants and their plant communities. It was the first of its kind in Britain and was quickly published in the Journal of the Linnean Society. Woodhead was soon being cited by ecologists across Europe and in the USA. The work was carried out not in the Swiss Alps, however, but within ten miles of his home town where, under Woodhead's ecological influence, key ecologically-minded figures became central to the activities of the Huddersfield Society from the first years of the 20th century.[119]

By 1905, Woodhead had already been a member of both the YNU and the Huddersfield Society for over twenty years, and President of the Huddersfield Society. He was joint-editor of the YNU's journal *The Naturalist* for nearly 20 years, from 1903-1932, and acted as the Union's Secretary from 1911 until 1920 when he became President. Like a number of other prominent members in both societies, he regularly gave lectures and staged exhibitions at Society meetings and 'conversaziones'. From 1901, the Huddersfield Society frequently met at the Technical College, where Woodhead had built and now ran the biology department.[120] Woodhead's teaching there was highly practical, with a strong preference for the use of real specimens, whether in the field or in the lab, rather than illustration.[121] Nevertheless, he applied numerous methods for promoting precise visual and material learning in the classroom, including diagrams, hand-coloured plates, drawing exercises, and micro-photographs, as well as models, skeletons, plant and animal specimens, dissection and

[119] Woodhead 1906; Pearsall 1940a; Sheail 1988.

[120] Woodhead's biology department was recognised at the time as "one of the best biological laboratories in the North of England...taken as a model by several other institutions...the facilities are such that work of a University standard can very well be carried through there." Cited by Alberti 2000: 154.

[121] Ibid.: 161.The strength of practical, observational pedagogy in biology in Northern English colleges at this time has been remarked by others, as have the close interconnections between amateur workers and professional biologists, and between the various spaces of life science practice, the field, the lab, and the museum (Lowe 1976; Alberti 2000; Kraft and Alberti 2003).

microscopic work. It is not clear what use, if any, he made of lantern slides in his teaching, but he certainly did so in lecturing to his fellow field naturalists. For the naturalists' society, like amateur scientific societies and professional associations everywhere, by the end of the 1890s the lantern lecture had become a ubiquitous form of address.[122]

Fig. 3.23. W.H. Sikes. *The Huddersfield Naturalists and Photographic Society at Doe Royd*, c. 1911. Woodhead Collection, Tolson Memorial Museum, Huddersfield.

Members heard lectures on birds, plants, fungi, geological formations, archaeological remains, historic buildings and many other subjects. But exhibits at conversaziones and meetings were much more numerous and varied than simple lantern lectures; they included a wide range of other visual aids, as well as natural specimens. Watercolour drawings, radiographs, lantern slides, stereographs, printed photographs and maps were all in evidence. Plant specimens were frequently on show, along with insects, snail shells, cases demonstrating the life histories of particular species, rocks, fossils and photographs of geological formations. Stereoscopes were made available for viewing stereo images, and microscopes with 'slides of botanical and physiological objects' and volcanic dust. The Society also had an active interest in early colour photography. At conversaziones in 1898 and 1900,

[122] The lantern was so integral to such meetings in Huddersfield that gatherings would be cancelled rather than proceed without it. HNPS Monthly Circular, no. 101 June 1899. HNPS Collection, Huddersfield Local Studies Library.

photographer member John Cook treated those present to 'Kromskop lantern evenings'.[123] In 1911, Woodhead even organised film showings at the recently opened local cinema.[124]

For these naturalists, whether in lab or lecture, classroom or conversazione, visual and material displays played a compelling role in mediating natural knowledge, in sharing experiences of field-collecting, handling and preparing specimens, and all the facets of natural history performance in general. I will return to consider more closely the relationship between photography and material collecting practices in chapter 6. For now I want to emphasise Woodhead's active role in such performances, both in the field and in the lecture room. Woodhead hosted and organised most of these events, and he contributed a wide range of exhibits to particular conversaziones. He appeared regularly as a speaker, using lantern slides for illustration, lecturing on everything from hedgerows to local geology and ancient hillforts, as well as his own and others' ecological work. In 1902, for example, he gave a lecture on "Water Plants, and how they adapt themselves to their surroundings", illustrated with 45 plant specimens and "many microscopic slides".[125] He also led related excursions, sometimes illustrating his talk in the field with photographic prints.[126]

Like William Smith, Woodhead led by example as much as by talk, energetically pursuing his own ecological fieldwork, as well as leading field excursions. He also brought the sociability of amateur fieldwork into his own research, infecting others with his enthusiasm for ecology. His innovative doctoral research entailed mapping woodland plant communities across 66 square miles of West Yorkshire countryside, together with a series of more detailed studies in individual woods. The fieldwork required was substantial. Woodhead was an energetic fieldworker and covered all the ground himself, but he also drew on the interests and assistance of others, chief among them fellow members of the HNPS, Hannah Sikes and

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[123] The Kromskop was developed by Frederick Ives in the 1890s, first as a colour stereographic viewer and subsequently with a modified lantern for projecting images using a three colour additive method. (Gernsheim and Alison 1965: 55)

[124] A 1911 letter from John Lambert, Secretary of Hibbert's Pictures, records the private hire of Huddersfield Picturedrome Cinema, to "project your films", asking Woodhead to ensure that "your people" are prompt, at 11am on Friday 17th November 1911. The letter does not indicate the character or provenance of the films, but Woodhead's 'people' were certainly HNPS members, since one of them, W. H. Sikes, responded to a notification from Woodhead, confirming his intention to attend. His postcard response carried a photograph of the assembled members of the HNPS. The Society's annual 'Syllabus' of events for the year also included lectures at the Town Hall, among them a talk from Dr. Edmund J. Spitta, 'Minute Creatures - Curious and Wonderful', illustrated with lantern slides and microscopic cinematography. (Lambert, John to Woodhead, T.W. 14 November 1911; Sikes, W.H. to Woodhead, T.W. 16 November 1911. TOL/TWW/Woodhead Collection.)

[125] HNPS Annual Reports 1902: 9. HNPS Collection, Huddersfield Local Studies Library.

[126] HNPS Annual Reports 1915-16: 6. HNPS Collection, Huddersfield Local Studies Library.

William Wattam, who assisted extensively in the field, whilst others provided help with soil analysis, preparing microscopic plant sections, drawings and finished maps.[127] Neither Sikes nor Wattam was a trained botanist but both were drawn to ecological work, by attending Woodhead's evening classes at the Technical College, and learned the required ecological skills by accompanying him in the field. Like other ecologists undertaking vegetation survey, they mapped vegetation, recorded species composition and photographed plant communities. Like William Smith, however, Woodhead was no photographer. He relied no less on photography during fieldwork, or in subsequent presentations on the ecology of plants and vegetation, but his published works were illustrated with photographs and drawings made by others, almost all members of the HNPS,[128] Hannah Sikes among them. Hannah's brother William Sikes was also a photographic member of the Society, and was particularly important to Woodhead's work, to which he contributed photographs over a period of almost three decades. When Woodhead published a profusely illustrated academic textbook on *The Study of Plants* in 1915, a great many of the book's photographs were taken by the Sikeses and other Huddersfield naturalists. Working together with Woodhead, these amateur naturalists and photographers integrated the Society's twin purposes of photography and natural history and reshaped the conduct of life sciences in Huddersfield.

The fullest realisation of Woodhead's application of visual and material tools for promoting the understanding of science, and especially sciences of ecology and the environment, came when he was appointed as Director in charge of the development of a new museum for Huddersfield. In his *Scheme for the Development of a Local Museum*, Woodhead presented his proposals to the Mayor and members of the Huddersfield corporation, at a

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[127] Woodhead 1906: 398. Hannah Sikes (1851-1926) and William Wattam (1872-1953) were committed society members. Both served repeatedly as vice-presidents of the Society from around 1904, when Wattam also took over the role of botanical recorder from Woodhead. Miss Sikes also acted as Treasurer and Wattam as President between 1911-1913. The Huddersfield Society was perhaps more progressive than most in accepting a woman for office in a public society of this kind. Hannah Sikes was doubtless a forceful character. She was the daughter of a successful worsted manufacturer, from whom she had inherited a substantial house, which she made available for society meetings (See Fig. 3.23).

[128] Woodhead also adopted other distinctively photographic methods. In order to assess the effects of shading on woodland undergrowth, for example, he exposed photographic printing papers to varying conditions of light and shade, to generate a standard for measurement and comparison. For reproducing multiple maps and overlays for detailed vegetation analysis, he took advantage of photography's capacities for print reproduction, making tracings of the large-scale ordnance survey base maps, to create 'negatives' from which he could print directly onto photographic papers (ibid.: 350).

meeting held at the Town Hall in 1919.[129] He proposed a particularly ecological vision for the new museum, emphasising especially the close, reciprocal relationships between human history, patterns of settlement, land use and industry, and the environmental conditions of the district. A Museum, he said, "should provide practical illustrations of the main factors in the environment of the community." The inspiration of the scheme was a recognition of the value of the intensive "study of the inter-relations of the main factor of Man's environment."[130] These explicitly ecological organising principles were given tangible form in a range of exhibits, from the more customary cased specimens (including a spectacular new bird room), to archaeological finds from local excavations, and illustrated displays explaining habitats, plant and animal communities and the dynamic development of vegetation under local environmental conditions, both natural and anthropogenic.[131] In promoting both his museum scheme and a wider understanding of natural history, ecology and local history, Woodhead emphasised the importance of records relating to these fields of study, and considered photographic records to be particular value. His proposal to the Corporation was itself illustrated with photographs describing local topography and characteristic vegetation types, all supplied by his friend William Sikes (Fig. 3.24).

Woodhead's surviving papers, which are still held at the Tolson Memorial Museum, also include a great many loose prints from botanical photomicrographs, some of which were reproduced in his published work. A few are labelled and mounted onto card, clearly intended for display. The collection also includes a limited number of other photographic prints, most

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[129] The museum opened in 1922. Huddersfield was rather late in acquiring a museum of its own. The first ever British scientific museum was established in Cornwall in 1815 (Naylor 2002: 498) and establishing local museums became something of an obsession for Victorian naturalists and antiquarians. One of the first purpose-built museums was established under royal grant by the York Philosophical Society in 1830. In the first decades of the 20th century, provincial museums established by such societies were increasingly adopted by local authorities, as expressions of civic pride, scientific aspiration and 'spaces of instruction and self-improvement.' Sheffield's Weston Park Museum had been established by the City in this way in 1875, whilst Hull opened its first municipal museum on a similar foundation in 1902. The collections and museum of the Leeds Philosophical and Literary Society, first opened in 1819, were turned over to the Corporation of Leeds in 1921. . An estimated 200 new museums are thought to have opened around Britain during the 19th century (Naylor 2010: 41; Lightman 2007: 199; Rupke 2009: 14). For details on the origins of the museums mentioned here, see www.yorkshiremuseum.org.uk/about-us/history-of-the-yorkshire-museum; www.museums-sheffield.org.uk/museums/weston-park/planning-a-visit/museum-history; www.leeds.gov.uk/museumsandgalleries/Pages/leedscitymuseum/History-of-Leeds-City-Museum.aspx . [Accessed 2 Apr 2016].

[130] Tolson and Woodhead 1921: 2-4.

[131] Woodhead's fellow ecologist and obituarist W.H. Pearsall recognised this ecological outlook and declared: "This remarkable museum is Woodhead's main contribution to national culture" (Pearsall 1940a).

notably a series of mounted enlargements showing typical West Yorkshire plant communities, dated variously between 1913 and 1928. The date of printing is unknown, but they were mounted as a set, and the mount edges show signs of framing, very likely for display in the museum. The mounts carry printed titles and captions, providing notes on vegetation and characteristic species (Fig. 3.25 overleaf).[132]

Fig. 3.24 W.H. Sikes. *Heather Moor on the Rough Rock Plateau, Honley Moor*. Fig. 6 in Thomas Woodhead, *Scheme for the Development of a Local Museum.* Tolson Memorial Museum, 1919.

Along with objects, photographs and maps, the museum displays also included a series of 14 coloured relief models depicting the ancient and recent history of 280 square miles of countryside surrounding Huddersfield, illustrating its geology, topography, climate, vegetation, human occupation, and their reciprocal influences in shaping the topography of the district (Fig. 3.26 overleaf). He advertised the museum energetically in the local press and more widely, and produced a series of illustrated handbooks, to be read in conjunction with the museum's displays, giving detailed technical information, along with maps, drawings and photographs.[133] The realisation of Woodhead's proposals for the Tolson Museum was the

[132] Woodhead Collection, Tolson Memorial Museum, Box: Miscellaneous notebooks etc.; TOL/TWW/Woodhead Collection/Photographs. (The Woodhead Collection is uncatalogued).

[133] Woodhead 1931a, Woodhead 1931b; Sheail 1988; Davies 1992. The relief models were mostly constructed at a scale of 1" to 1 mile but Woodhead also commissioned maps and models at 6" and 25" to the mile. Each model formed the centrepiece of a different exhibit in the museum. Woodhead also made numerous duplicates of the models for lending to schools and even transported 12 of them to present at the International Botanical Congress in Cambridge in 1930.

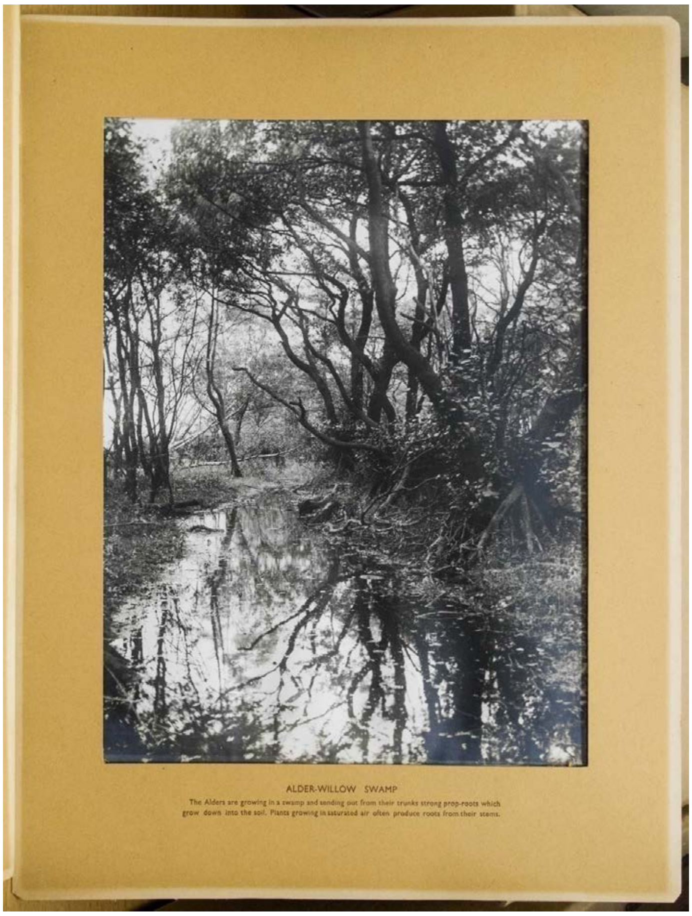

Fig. 3.25. *Vegetation types in West Yorkshire*, c.1913-14. Photographers and date of printing unknown. Woodhead Collection. Tolson Memorial Museum, Huddersfield.

culmination of nearly three decades work to bring a new perspective into amateur natural history and municipal education in biology. Under the influence first of William Smith, and then Thomas Woodhead, the direction of life-science in Yorkshire, in both its professional and amateurs guises, was given a strong ecological inflexion. The development of ecology, in turn, was associated with a rich visual and material culture, inherited in part from the common practices of local amateur natural history, but also characterised by innovative visual and educational strategies for fostering understanding of the new science much more widely.

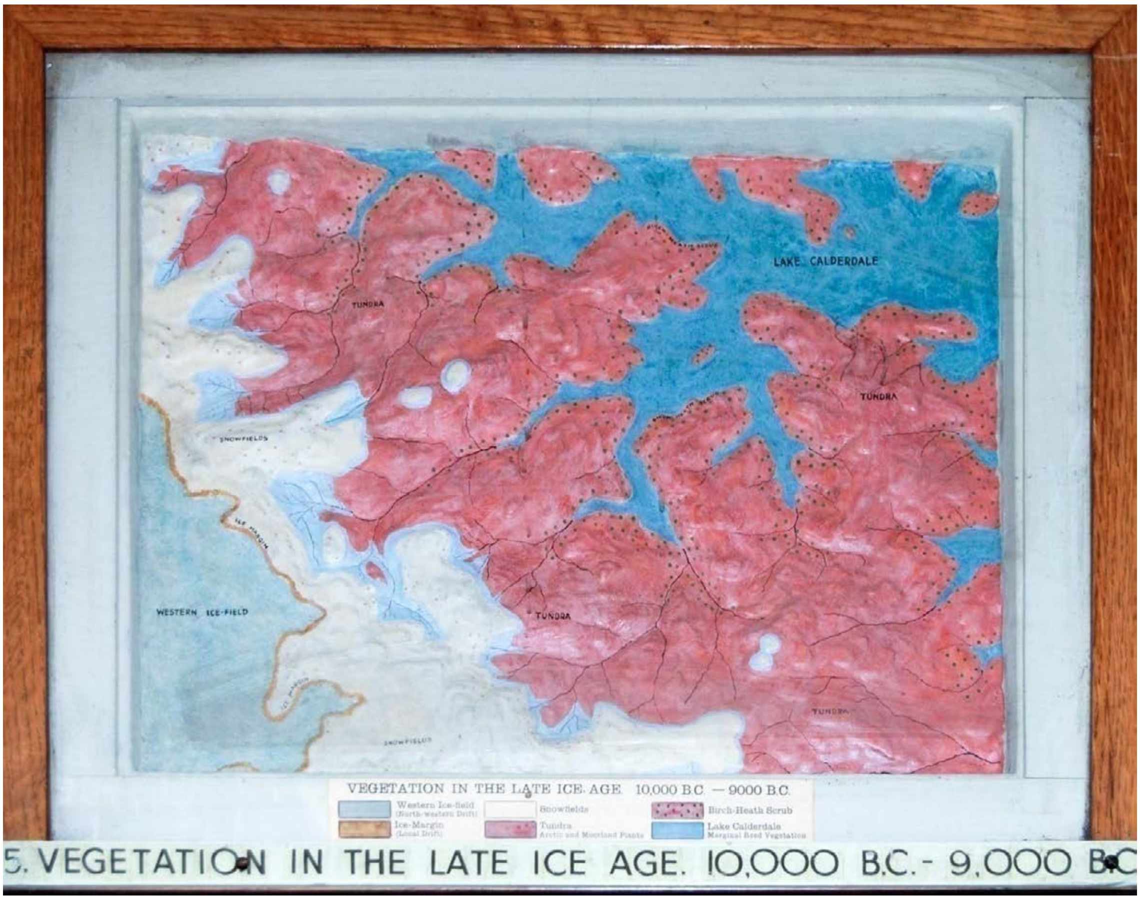

Fig. 3.26. *Vegetation in the Huddersfield District in the Late Ice Age.* Plaster Relief Model c.40" x 56". Tolson Memorial Museum, Huddersfield.

Nevertheless, the successes of ecology in the amateur community can easily be overstated. The picture in Yorkshire was not widely repeated elsewhere and, even in Yorkshire, many naturalists remained unconvinced that the 'new natural history' should replace the old. When Woodhead was appointed director for the new museum, for example, Seth Mosley was appointed its first curator, but was none too happy with the arrangement. An archetype for the self-taught Victorian naturalist, he and Woodhead embodied entirely different perspectives on the natural world and its study.[134] Mosley was a general naturalist, but even among Yorkshire botanists, where ecologists might expect easier converts, it was not easy to enlist, especially from the ranks of established floristic workers. The central problem remained that of persuading botanists of the reality of plant associations. Frederick Arnold Lees (1847-1921), for one, a former President of the botanical section of the YNU and respected author of *The Flora of West Yorkshire*[135], was far from convinced that he should throw over his customary practices of collecting and naming taxonomic varieties in favour of ecology. Lees feared that academic botany was stealing a march on field natural history, at the hands of professionals like William Smith and Arthur Tansley. In November 1911, Lees wrote to Thomas Sheppard, co-editor with Woodhead of *The Naturalist,* apprehensive to know more about a new book on vegetation.

> I've grown to fear that these high and dry, scientifically aloof young workers who receive salaries for their scholars work are pricking ahead faster than I can follow…for look you — a well meaning Margerison now writes me, there's a work on Types of Vegetation by Tansley of Cambridge, which you, Lees, MUST see. Need I. If you've got it for review, can I see it — even review it? Or must some other teacher undertake the task from a log-role standpoint? The academic snail's horns of enquiry are being perked out just now and no mistake.[136]

Lees had his wish and, in January 1912, wrote a short review for the journal, titled *The 'New' Botany*.[137] The review was somewhat bewildered. He found it "a difficult book to review" he said, "since with neither desire to pick, nor possibility of picking holes in the fabric…there is little but a sort of struck-dumb praise to be accorded." His dumbstruck praise almost certainly reflected a lack of understanding. He predicted that the book would become the classic text

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[134] Davies 1992. Mosley was aggrieved when the Corporation's new museum committee gave him little or no freedom to develop the collections and displays in his own way. He felt his experience in the management and museum display of natural history collections was not given due recognition. He had opened a private museum as long ago as the 1880s, before transferring to the Society's museum at the Technical College in 1901. In fact, the appointment itself was probably intended as recognition for Mosley's long commitment to the town and its natural history, but he was 72 years old when appointed curator and unlikely to adopt a radical new way of thinking. Mosley dissatisfaction, expressed as frustration with his treatment at the hands of civic bureaucrats, was refracted through the lens of institutional in-fighting and social recognition, but his disagreement with Woodhead also reflect profound differences of natural history tradition.

[135] Lees 1888.

[136] Frederick Arnold Lees to Thomas Sheppard, 15 November 1911, Woodhead Collection, Tolson Memorial Museum, Huddersfield.

[137] Lees 1912: 11. The review was also painfully polite. Contrasting the work with popular *plein air* natural history, Lees remarked on the progress of "the perhaps almost too strictly Academic side of Botany," by which he meant not the prevalent morphology of the University botany lab but the work of systematic vegetation survey and the influence of the 'Central Committee'. His reluctance to criticise may, in part at least, have been because the journal's editor was Thomas Woodhead, one of the academic 'new' botanists about whom he felt so uneasy.

for its subject, and declared it "much better adapted than any other Manual I know for enabling the rank-and-file field-naturalist to find the excelsior charm in understanding what he sees." It was of course the *only* manual of its kind, and it seems that Lees did not understand it at all. Not only were his criticisms slight, his observations on content were superficial, and nowhere did he engage with the book's central aims, or discuss any of the vegetation types it described, let alone the concept of the plant association. The work of preparing the book, he thought, must often have been 'tiresome'. His lack of comprehension, it seems, was allied to a lack of real interest in the new ecological outlook. Ecologists reading the review and still hoping to convert amateur botanists to their way of thinking would surely have been dispirited. They might have taken small assurance from Lees' only real enthusiasm for the book — its photographic illustrations — which he thought rescued the work — before feeling further dismay as Lees concluded, the book "no doubt will presently be in the hands of every Council School Teacher who takes his Nature-Class into the open."

4. Picturing Vegetation: The print cultures of ecology

When we consider the distribution of the plant-life of any given region or country, whether large or small, we find that it may be regarded from two distinct points of view.[1]

It is clear from the story of their efforts to transform their newly self-conscious subject into a recognised scientific discipline that ecologists shared much with botanists, and especially with amateur naturalists. In particular, they shared a common culture of the field, and some of its related visual practices. They shared also a common set of discursive and performative practices for sharing and regulating scientific knowledge, in public performance and private talk, in which photographic displays were prominent, often alongside other visual and material objects. Nevertheless, if the fate of the BAAS Botanical Photographs Collection is any guide, the photographic representation of plant associations was not so straightforward as its proponents assumed. Common visual ground between ecology and botany only extended so far. Many botanists, like Frederick Lees, either did not grasp, or actively resisted the ecologist's new way of looking at vegetation. The established botanical view had been constructed and reinforced over at least three centuries, supported by many of the same field practices and the same networks of association and exchange through which ecologists sought to promote their new perspective. Perhaps most importantly, for all those three centuries, botanists had been drawing up their species lists and floras for print publication.[2]

Early ecologists, consequently, quickly recognised the importance to their project of developing a strong print culture. Such a project should be seen in the context of a universal turn to print publication in the circulation of scientific knowledge of all kinds, especially towards the end of the 19th century. By the 1890s, scientific journals in particular had become a "primary seat of public knowledge claims."[3] Scientists looked increasingly to specialised scientific periodicals to establish authority for their own research, to see what their colleagues and scientific peers were doing, how they were doing it, and what they thought about it all. By the beginning of the 20th century the print culture of scientific journals had become central to the development of and maintenance of the imagined disciplinary communities for science of

[1] Tansley *et al* 1911a: 1.
[2] Allen 2003.
[3] Csiszar 2015: 150.

all kinds.[4] At the same time, from the 1880s and 1890s, the emergence of an illustrated press able to exploit new technologies of photomechanical reproduction (principally the halftone print) had begun to offer new possibilities for visual communication in print[5]

Published accounts of ecological work helped to press home the aspirant status of ecology as a legitimate science, reinforcing the message presented in the parallel contexts of scientific meetings and lecture halls, and extending its reach to a larger audience. Of particular importance in this respect was the international character of print culture in this period, which allowed ecologists to exchange knowledge, experience and practice across Europe, North America and more widely. When considering the visual practices of science in the cultures of talk and display, the character of verbal and visual representation is not always easy to grasp from an historical distance. The print culture of ecology provides partial historical access to this elusive visual field, because at least some of what was shown in the lecture hall was also reproduced in print. Most importantly, more than any of their contemporary biologists and field naturalists, ecologists made intensive use of print publication as a visual medium in its own right, relying especially on photographic illustration to communicate their new approach to understanding the natural world. Paying attention to the pictorial content and function of these publications, we may appreciate more fully the visual quality of ecological practice and epistemology in the early 20th century.

Historically, photography had never been very good for illustrating plants, and botanists had greater faith in the eye and hand of the botanically trained artist to describe the key elements of form, especially those required to confirm taxonomic identification.[6] Systematic

[4] Csiszar 2010: 400.

[5] For a thorough history of the rise of the halftone print in the illustrated press, see Beegan 2008.

[6] When William Henry Fox Talbot first sent a specimen of his photogenic drawings to William Jackson Hooker (later the Director of Kew Gardens), in March 1839, Hooker was unconvinced of their value as direct representations of plant specimens. A photogenic drawing of a flower, he thought, was "very pretty as to general effect, but it did not express the swelling of the flower, not the calyx, nor the veins of the leaves distinctly." (Hooker to Talbot, 20 Mar 1839. Talbot correspondence Project no. 3842; Hooker to Talbot, 21 Jun 1839. Talbot correspondence Project no. 3895). Hooker saw greater value in photography for reproducing botanical drawings. Twenty years later, when photography had advanced considerably, and Talbot sent him more photographic specimens, Hooker was still not satisfied that photographs were appropriate or adequate to the task of botanical representation (Hooker to Talbot, 11 Sep 1859. Talbot correspondence Project no. 7954). This remains the case today. Popular photographic botanical guides have only become commonplace with digital photography, whose multiplicity allows rapid comparison between numerous instances of the same species. Even so, botanical taxonomy still relies on preserved herbarium specimens and hand-drawn

botany naturally draws representation towards the typical. Visual representation in taxonomic botany yields illustrations, exemplars but never a specific instance. Photography on the other hand favours the idiosyncratic, the individual, the distinctive; it cannot perform the generalisations of taxonomy without the aid of the classifying eye or the drawing hand. Even had photography been capable of rendering clearly the minute morphological variations that distinguished one species from another, its inability to differentiate between significant variation and inconsequential aberration made it problematic for botanical illustration. Botanists, consequently, favoured hand drawings over the undiscerning mechanical eye of the camera.[7] Ecologists, by contrast, were concerned with particular instances, with variations that may be taxonomically irrelevant but indicative of environmental response and, in the study of vegetation, with real instances of plant association. They were interested in classifying vegetation too, but the recognition of consistent, stable plant communities had to be built from the ground up, founded on new observations from real stands of vegetation. From the very start, therefore, whether as prints or in lantern displays, photographs were always the ecologist's preferred mode of presentation. Other botanists used photography but ecologists distinguished themselves by a particular devotion to photographic representation in print. In the 1890s and 1900s, the pages of key American journals in particular were subject to an explosion of photographic illustration, associated with the arrival of papers of an ecological character. In 1901, the USA's leading botanical journal, the *Botanical Gazette*, was still dominated by studies in morphology, botanical geography, taxonomy and physiology. The pages of a typical paper included line drawings, but rarely photographs (Fig. 4.1). The contrast with ecological papers was marked. A second set of pages (Fig. 4.2) is typical of the three ecological papers published that same year, all of which were notable for a profusion of photographs.

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illustrations to make critical morphological distinctions between species. Professional botanists still prefer their field-guides with hand drawn illustrations to separate out these critical diagnostic features.

[7] Drawing skills were part of the fundamental training for botany and the predominance of hand drawings over any other form of visual representation can be seen in any of the major botanical journals throughout the 19th century, such as the *Botanical Journal of the Linnean Society* (est. 1856) or the *Annals of Botany* (est. 1887). The use of photomicrographs was something of an exception. Photomicrosopy was widely practiced amongst botanists and most other life scientists. Even here, however, hand-drawings were often preferred by some, whether direct from microscopic observation, with the aid of a camera lucida, or copied from photographs.

Fig.4.1. J.H. Schaffner, 1901. "A contribution to the life history and cytology of Erythronium." *Botanical Gazette*, 31**,** 369-387.

Fig.4.2. H.N. Whitford, 1901. "The genetic development of the forests of northern Michigan; a study in physiographic ecology." *Botanical Gazette*, 31**,** 289-325.

In both the USA and in Britain, the early development of ecology was marked by this pronounced shift in the character of illustration in botanical journals, which reflected a shift from floristic, species-based botany to the vegetation studies of ecologists. In Britain and the USA, ecologists published in these botanical journals, but also launched new journals of their own, and published new textbooks to promote their science, routinely deploying photographs, both as scientific evidence and as evidence for scientific practice. Ecologists elsewhere in Europe adopted similar strategies, including some ambitious photographic projects, but here the transition from floristic to ecological phytogeography was less clear. As the following discussion shows, print and publishing cultures were important in establishing and professionalizing ecology, especially in Britain, securing its scientific status against an indifferent or hostile botanical establishment. At the same time, however, the print cultures of ecology more widely revealed contrasting traditions, and a related epistemological disparity, between British (or Anglo-American) vegetation science and continental European phytogeography. That disparity was apparent in the differing photographic expressions of ecologists in the two traditions, even as they both used photography to support and promote their ecological studies.

The New Phytologists

In Britain, ecological publishing arose more or less in opposition to established botanical practice. Well into the 20th century, mainstream botany largely remained either ignorant of, or antithetical to, ecology and offered few opportunities for ecological publication. A small number of ecological papers did appear in one or two major botanical journals, including the *Botanical Journal of the Linnean Society* and the *Proceedings of the Edinburgh Botanical Society.* These were isolated exceptions, however, and largely coincided with periods in which ecologists played active roles in those societies.[8] The influence they exerted in such circles was relatively minor, however, and ecologists could only achieve greater exposure and readership for their subject by making their own publishing opportunities; which is precisely what they did, almost entirely through the foresight and energies of Arthur Tansley.

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[8] Tansley and Oliver were both active in the Linnean Society including roles in its library committee. William Smith was especially associated with the Botanical Society of Edinburgh and the Scottish Botanical Review. (See also *Professional associations* in Chapter 3 of this thesis).

In 1902, one could barely have recognised Tansley as an ecologist. On his own account, he had so far published only a few notes on morphological themes relating to ferns and bryophytes. He had yet to meet William Smith and was unaware that vegetation survey work was already underway in Scotland, which had found publication not in a botanical journal but in the *Scottish Geographical Magazine*. Tansley had, however, taught himself German, so that he could read some of the more important botanical texts that were unavailable in English, and had thus read two of ecology's most influential founding texts, Andreas Schimper's *Pflanzengeographie aufphysiologischer Grundlage* and Eugene Warming's *Plantesamfund* (in German, *Lehrbuch der Ökologischen Pflanzengeographie).* He had even begun to use Warming's book as a basis for teaching, and his interest in vegetation had been particularly sparked by an expedition to the tropics in 1900-01.[9] In 1902, he privately launched a new botanical journal, *New Phytologist,* which was to become the voice of British ecology for its first decade. Originally conceived as "a medium of easy communication and discussion between British botanists,"[10] the journal was intended as a more or less informal means of information and research exchange, in particular to fill a perceived gap in relation to botanical physiology. The *Annals of Botany* and the *Botanical Journal of the Linnean Society* provided the academic lead in such matters but tended to be dominated by morphological studies on the one hand (*Annals*) and taxonomic matters, together with floristic phytogeography on the other (*J. Linn.Bot.*) A less academic journal, catering for informal communications in botanical science already existed, in the guise of the *Journal of Botany.* However, the existing journal, which had been established in 1863 as a popular informal outlet for botanists, especially for amateur collectors and professional herbarium curators, was firmly floristic and taxonomic in outlook.

Tansley aimed to promote a new emphasis in British botany. His new journal laid a greater stress on physiological matters and addressed itself more to botanical education and training than did established publications. In its first year, however, the reforming agenda of the new journal lacked focus. Early issues resembled other current botanical journals to a significant degree, both in subject matter and in illustrative content, which chiefly comprised line drawings, many from microscopic observation, and occasional photomicrographs. Photographic illustrations were not, initially, a feature of the journal, which remained a slight

[9] Godwin 1977; Warming 1896; Schimper 1898.
[10] Tansley 1902b: 1.

and cheaply printed publication.[11] The first photographic reproduction was a typical botanical photomicrograph, of a slide prepared from a fossilised fern.[12] The short paper in which it appeared was entirely morphological in character and could have been carried by any of the contemporary botanical journals. Nevertheless, Tansley's growing interest in vegetation ecology was also quickly evident. In April of the first year, he included a short editorial entitled 'ecological notes', giving his first thoughts on ecological research and the need for vegetation surveys.[13] Before long, *New Phytologist* had become the primary British vehicle for promoting and reporting ecological research, providing a public voice for the new science and for a small community of ecologists, centred initially on the members of the BVC but ultimately encompassing similar voices from Europe and North America. Photography also quickly became central, not only in ecological methods for vegetation survey, but in the subsequent publication of survey results, where they carried evidential weight for the recognition of plant associations and ecological processes, and in promoting ecology as professional science.

New Phytologist's first original ecological paper was published in October 1903. In the first published micro-study of vegetation succession in Britain, Marie Stopes described the colonisation of a dried-up river bed by new vegetation.[14] It was a modest but genuinely pioneering study for British ecology. Tansley's own engagement with practical ecology was first indicated in a short note in July 1903. In his brief account of "An experiment in ecological surveying," he recounted his first efforts at detailed ecological survey and vegetation mapping during a field excursion to the Norfolk Broads and coast of East Anglia, with Frank Oliver and a group of advanced botanical students from UCL. These first surveys were methodologically tentative and Tansley presented the work as provisional and pragmatic, intended chiefly "to bring the members of the party into intimate contact with these extensive and practically untouched 'plant communities'".[15] The approach adopted reflected the strong visual basis for early vegetation study. It also marked the first British attempt directly to apply basic ecological analytical principles to the investigation of vegetation distribution, by mapping transects along a range of environmental gradients, including topographic variations, soil characteristics and water levels.

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[11] Godwin 1985. Tansley had sought support from senior botanists without success and so met the costs of publication himself for the first 2 years, at which point it began to make a small profit.
[12] Benson 1902.
[13] Tansley 1902a.
[14] Stopes 1903. Stopes completed a BSc in botany at UCL in 1902, where she was taught by Tansley and Frank Oliver.
[15] Tansley 1903: 168.

It was soon followed by a second expedition in 1904, this time to the coast of northern Brittany in France, to an area known as the Bouche d'Erquy. Tansley, at least, thought the work was ground-breaking. The expedition took place from August 27th to September 10th. The following month, without waiting for the final results of data analysis, and before fair copies of the vegetation maps could be drawn up, he published an account of the continuing experimental work in *New Phytologist*. In satisfied and typically understated British terms, he celebrated the outcome of the expedition, concluding that "the experiment, in its way rather ambitious, may be said, on the whole, to have been an unequivocal success."[16] Between 1904 and 1908, with the assistance of numerous students, Oliver, Tansley and others continued their experimental programme at Erquy.[17] These excursions made important methodological contributions to early ecological field study in Britain but, perhaps more significantly, as collaborative experiments involving a number of ecologists, drawn from different institutions and geographical locations, they also played a role in determining the more general conduct of excursionary outings amongst ecologically-minded botanists in the coming decades. They provided a model for social and disciplinary exchange in ecology, and established many of the geographical locations and kinds of habitat in which ecological science was cemented through such exchanges. The International Phytogeographical Excursion of 1911 was the most notable of these, but the sites visited during the IPE were established through members of the BVC whose knowledge of the different landscapes and vegetation of Britain were formed in studies like these 1911.[18]

The results of the 1904 Erquy work were written up more fully, by Oliver and Tansley together, in the December issue of *New Phytologist*, specifically to elucidate the methods more clearly. This second 1904 paper marked a significant adjustment in the use of illustration in a British botanical Journal, for two distinctive innovations. Firstly, its graphic illustrations included the first published use of precise, large-scale vegetation mapping, showing the separation of distinct plant communities in a quantified area. In addition, a large, whole-page plate was devoted to a photograph showing the area of vegetation under scrutiny, and the

[16] Tansley 1904b: 204.

[17] Tansley 1905; Smith 1906; Oliver 1906, 1907; Hill 1909. The survey party in 1904 consisted of 27 individuals, mostly from UCL, but also from Cambridge University botany school and the Royal College of Science (subsequently Imperial College); in 1904, William Smith was also present and contributed to the detailed monitoring work. In 1905-1907, the party comprised about 20 members. Tansley left UCL for a lectureship at Cambridge in the Autumn of 1906, but Oliver continued the expeditions until 1908.

[18] See chapter 5 for further analysis of these early experiments in ecological method.

new method of survey in operation.[19] More such pictures appeared in subsequent years, showing ecologists engaged in various kinds of scientific work (Fig. 4.3) and, as the Erquy surveys progressed, reports continued to appear in the pages of *New Phytologist.* On each occasion, Oliver summarised the results of investigations, deploying more photographs of the work underway, showing work both in the field and in the lab.[20]

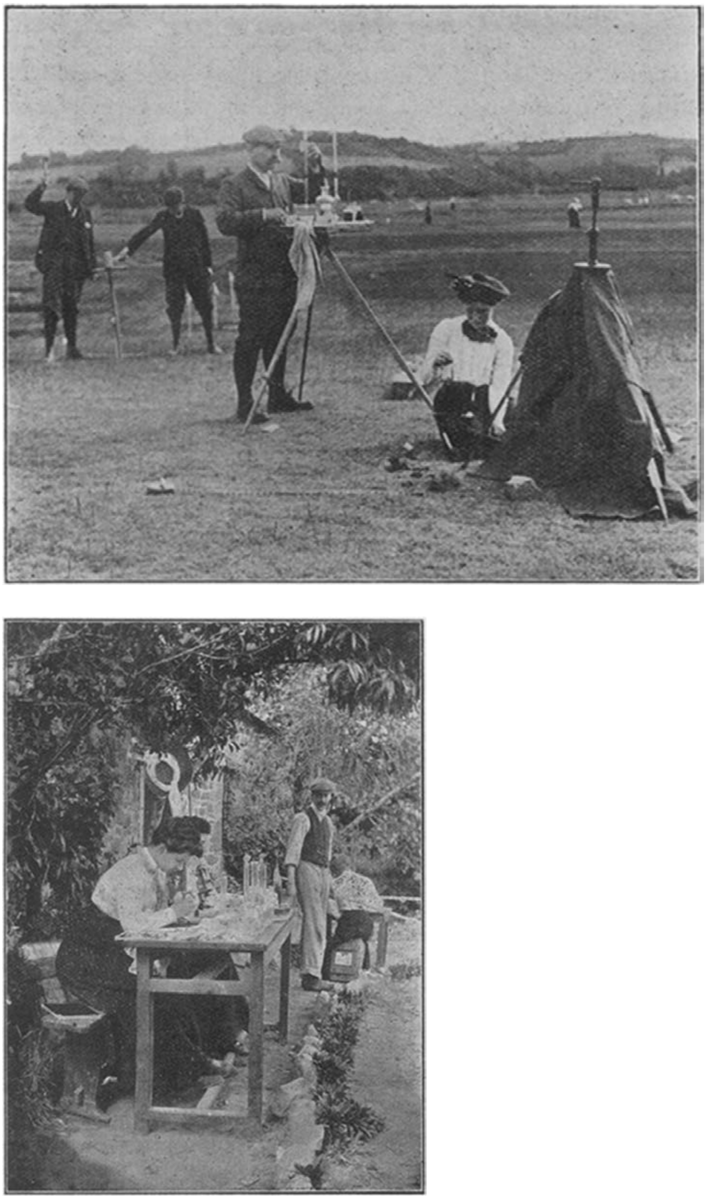

Fig. 4.3. Frank Oliver. Bouche D'Erquy in 1906, in the field and at the Laboratory cottage. From Oliver 1906.

[19] Oliver and Tansley 1904. See Fig. 5.14 in chapter 5.

[20] Tansley left UCL for a lectureship at Cambridge in 1906 and presumably had no further direct involvement in the work.

From 1905, a nearby empty cottage was turned into a temporary indoor workspace, and the 1906 pictures included a plate to show a well-equipped lab for analytical work. Like Oliver and Tansley's report from 1904, these pictures showed ladies undertaking fieldwork in full Edwardian skirts and fashionable hats, and men in britches, jackets and flat caps. Such field-dress aside, there seems to have been no gendered division of labour in conducting either the field or the laboratory work. But the primary significance of the pictures was, once again, to show ecological work in progress. This was no frivolous botanising trip, it was serious science, exploring new ways of understanding the natural world. Photographs depicting traveller botanists were plentiful in the late 19th century, but almost always as portraits; they rarely depicted scientific investigations in progress. These photographs illustrated not only a novel object of study, and novel scientific methods in progress, they depicted scientific investigation 'in the field', supporting one of ecology's primary points of departure from the old 'new botany'. These investigations took botany out of the laboratory and into the living environment of plants. The pictures revealed the human agency in scientific work, which was excluded from the unpeopled images more usually to be found in botanical journals, of specimens and dissections, consistent with late 19th century values of 'objective' scientific observation.[21] For Tansley, these experiments in ecological method were of great importance. They were of great value for education, he thought, and should be seen as a crucial element in the training of advanced botany students. Most importantly, they were critical to driving forward the scientific project of ecology, in developing new methods and new ecological insights, and for establishing ecology as a legitimate branch of botanical science.

The studies at Erquy also brought innovations in the visual investigation and representation of vegetation. In the reports from 1907 and 1908, for example, the results of repeat recording in small areas of vegetation were graphically illustrated by means of comparative sketch-maps to show colonisation by pioneer saltmarsh plants. This was the first published example of the systematic monitoring of vegetation development, and its visual

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[21] For an account of the separation between laboratory science and fieldwork, see Kohler 2002a; for a well-developed understanding of the notion of 'objectivity' and its history see Daston and Galison 2007. For many mainstream botanists, images showing ladies in fashionable Edwardian dress, botanising in the sunshine, were uncomfortably close to an amateur naturalists' excursion, with attendant anxieties regarding dilettantism and a lack of scientific rigour. Such anxieties were repeatedly expressed in relation to ecology and other field sciences. The participation of women in scientific fieldwork, especially in amateur spheres, was itself problematic for some, and this is reflected in concerns expressed in contemporary accounts of amateur field excursions (Allen 1976: 148; Alberti 2000: 191).

presentation in the form of comparative charts. In addition, in 1907 and 1909, many of the reported observations concerned changes in the colour of the vegetation, for which colour photographic experiments were attempted. The reproduction of colour images in print would have presented technical problems at this time and would also have been prohibitively expensive for a small independent journal, and they were never published.[22] The *New Phytologist* reports were never intended as full scientific descriptions, however, and did not include photographs from the detailed vegetation plots at Erquy. The reports were intended to be accessible accounts of the conduct of new experimental methods in a young science. The photographs included by Oliver in the 1904 and 1906 reports fulfilled this function, by showing the ecological work in progress. I will return in greater detail to the visual methods employed during UCL expeditions, in chapter 5.

It was a matter of prime importance to the progress of ecology that such innovative vegetation studies should be given exposure in the wider botanical world. It was important also that the new ecological perspective on vegetation should itself be presented in broader terms. *New Phytologist* was also, therefore, a vehicle for the first British accounts of vegetation. These accounts began not with reports of systematic surveys, or intensive studies, of which there had still been very few by 1905, but with descriptions based on the personal records and recollections of botanists' expeditions and excursions to different places around the globe. In 1905, the journal began an irregular but sustained series of papers under the general title of 'Sketches of Vegetation at Home and Abroad'. The aim of the 'Sketches' was to "record from time to time personal impressions and observations of characteristic floras in various parts of the world."[23] In other words, the *Sketches* were intended to report on direct personal and scientific observations on vegetation, made by botanists working in particular locations. Whilst this was not the primary descriptive survey work sought by the BVC, it differed notably from previous vegetation accounts, which were largely synthetic and based on the disparate records and observations of numerous different floristic botanists and collectors. Most existing observations were not made with vegetation physiognomy or plant associations in mind; they required considerable interpretation, based on these authors' own extensive experience and knowledge, to rein them in to generalised categories of plant-formation. In the very first of the 'Sketches', written by Tansley together with Felix Fritsch

[22] Oliver 1907; Hill 1909.
[23] Tansley and Fritsch 1905a: 1.

THE NEW PHYTOLOGIST. VOL. IV. PLATE I.

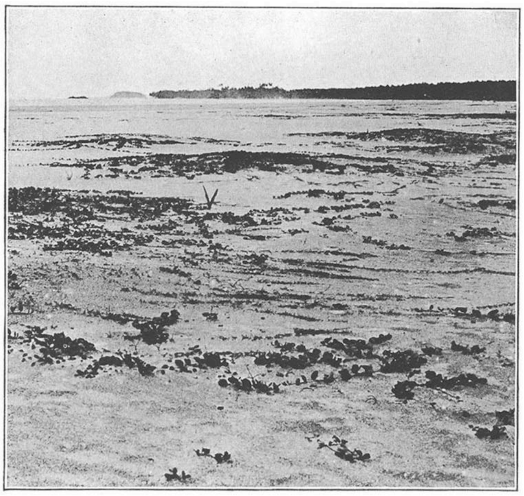

Fig. 1.

Fig. 2.

Fig. 1. The Pes-caprae formation (outer zone). Ipomœa biloba (Pes-caprae) in foreground and middle distance; Zoysia pungens just behind the front plants of Ipomœa; young plant of Crinum asiaticum in middle distance. The view is looking obliquely across the shore to the sea, with a wooded headland beyond.

Fig. 2. The Pes-caprae (inner zone) and Beach jungle formations. The thick carpet of vegetation in the foreground mainly composed of I. biloba. Behind, Crinum asiaticum (in flower), Pandanus odoratissimus (to right), and young Coconuts.

Both figures from photographs at Bentotta (Ceylon) by Mr. A. K. Coomaraswamy, by whose kind permission they are reproduced.

TANSLEY AND FRITSCH — FLORA OF THE CEYLON LITTORAL.

Fig. 4.4. A. K. Coomaraswamy. *Flora of the Ceylon littoral.* From Tansley and Fritsch 1905a.

(1879-1954), his UCL colleague and a specialist in algae, the subject was the coastal vegetation of Ceylon (Fig. 4.4). At forty-eight pages, published in two instalments in consecutive issues, it was much the longest article published in the journal up to that date. The authors acknowledged a debt to Andreas Schimper's knowledge of tropical vegetation but, based on their own observations, they questioned and corrected a number of his plant-formations from the region.[24]

Consistent with the series' general title, the 'Sketches' described not only exotic, tropical vegetation. Later examples considered the vegetation of Wicken Fen in Cambridgeshire, and an island in the Baltic Sea, as well as locations in Norway, S. Africa and S. Australia. The papers were liberally illustrated – a strategy highlighted among the stated aims of the series – with hand-drawn maps, topographic sketches and drawings of plants and with photographs intended to show real examples of the vegetation units described. The plant-sketches also marked a departure from earlier botanical illustration because they were intended to depict not the typical morphology of a species, or its variants; rather, like Richard Yapp's lab photographs of water plants, they were meant to show specific adaptations to environmental conditions. Photographs provided visual evidence of the vegetation and environments described, following the examples established by the brothers Smith, and by a handful of ecologists publishing at this time in American botanical journals. These papers mark the first serious analytical treatment of vegetation along ecological lines in British botanical science. They described species-composition, vegetation structure and the ecological relations of plants as the components of larger plant associations or vegetation communities. They described physical habitats and the characteristic plants of different vegetation 'formations', together with a wide range of morphological and environmental adaptations, describing in detail the zonation of plants and vegetation types along one or more environmental gradient.

Autecological studies, investigating the environmental adaptations of plants, were also represented for the first time in *New Phytologist.* In April 1905, in a short paper on the

[24] Tansley and Fritsch 1905a. Both Tansley and Fritsch had separately participated in expeditions to the far east, including Ceylon. The level of detail included in the paper, with respect to the physiognomy and species composition of the vegetation, suggests that both had made meticulous records and observations whilst travelling in the region. Many of Tansley's observations can be found in a diary he kept during his voyage to Ceylon, the Malay Peninsula and Egypt, between 1900 and 1901. "Diary kept in the East 1900-01." Tansley Papers, Cambridge University Library, CUL/Tansley Papers/A.18.

THE NEW PHYTOLOGIST. Vol. IV. Plate II

Fig. 1.

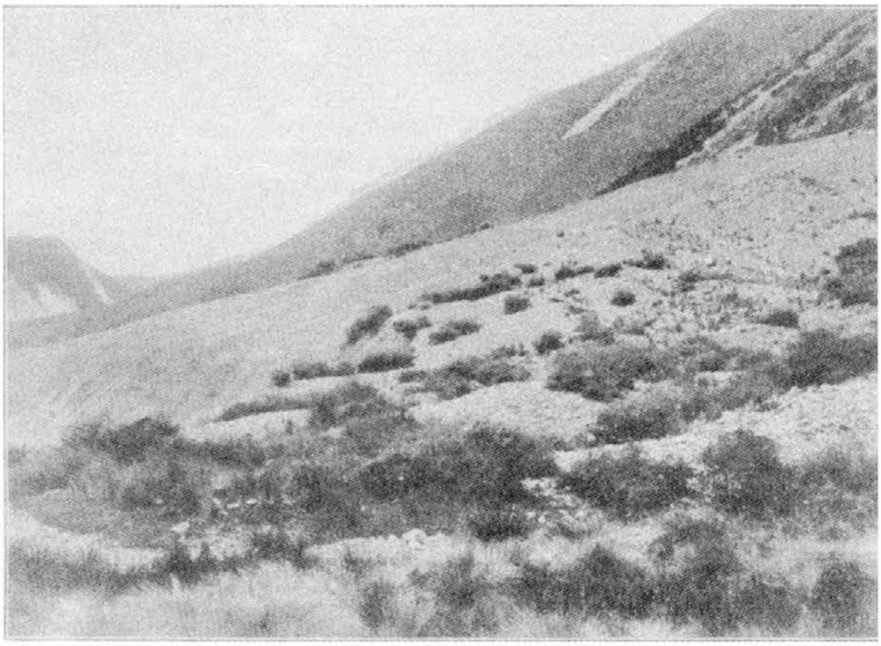

Fig. 2.

COCKAYNE—DISCARIA TOUMATOU.

Fig. 4.5. Leonard Cockayne. *Discaria toumatou.* From Cockayne 1905.

adaptation of spiny plants to drought, New Zealand ecologist Leonard Cockayne questioned the post-Darwinian emphasis on biotic competition and resource limitation as selection pressures for adaptation and speciation. For the most part, he pointed out, the effect of environmental conditions were largely overlooked. Cockayne's paper placed the environment in which plants grew at the centre of attention, supported by photographs showing growing experiments which had demonstrated morphological adaptation in response to particular habitat variables (Fig. 4.5). The photographs tied together field study and laboratory investigations, pairing the characteristic habitat of the species, with the results of directly related experimental work.[25]

Finally, and just as importantly for ecology's first steps, Tansley ensured that *New Phytologist* would broadcast the progress of ecological work in general, and the development of British ecology in particular. The reports from Erquy and other studies were compelling advertisements in themselves, but regular features of the journal also included book reviews, summary accounts of ongoing researches at home and abroad, and notices of the research activities and appointments of individuals within Tansley's professional network of contacts, colleagues and friends. Most importantly, it provided a reporting forum for the BVC. The Committee's formation was first reported in an extended notice in *New Phytologist*, together with a report of its first meeting. In April 1905, Tansley devoted the pages of his journal to publishing the Committee's guidance pamphlet for *Beginning Survey Work on Vegetation*, promoting both the Committee and its new ecological approach to vegetation study.[26] *New Phytologist* became the central location for reporting on the progress of this new survey movement and, from this point forward, the character and emphasis of the journal's content shifted decisively in the direction of ecological concerns.

A Journal for ecology

New Phytologist was the flagship and early mouthpiece for the British vegetation survey movement, but it was not well suited to provide a similar service for an independent discipline. Despite its success and a steady flow of ecological papers, *New Phytologist* remained, as Tansley had first conceived it, a magazine of general botany, and continued to cater to a wide botanical audience. Consequently, many ecologists, including Tansley, felt there was still no clear publishing home for ecological studies. Scottish professor of botany

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25 Cockayne 1905.

26 Smith 1905a.

James Trail pointed out as much in his Presidential Address to the BAAS botanical section in 1910. Trail was not an ecologist but had observed both the "excellent work" being done in plant ecology and the fact that much of it was overlooked because its reports were dispersed across a wide variety of journals, including some that were not even botanical.[27] In his first Presidential address to the British Ecological Society in 1914, far from arguing for a place within established botany, Arthur Tansley emphasised ecology's distinctiveness. "Ecology is not in fact primarily a specialised branch of botany at all," he said, "but a way of regarding the plant world."[28] As the British Vegetation Committee transformed into the BES, therefore, and British ecologists were feeling the warmth of international recognition, Tansley convinced the new society that it should "seize this psychological moment" to launch the world's first ecological journal.[29] Ecology had not achieved anything like general recognition among botanists and occupied almost no time in University curricula. Nevertheless, the new journal would carve out ecology's scientific place in the world, irrespective of recognition within the botanical establishment.

The primary audience for the new *Journal of Ecology*, consequently, would be the growing body of ecologically-minded botanists and the journal would aim to encourage that growth further, and guide its development. The journal would be a place of methodological development and review, featuring articles on general survey methods, mapping and charting methods, and the instrumentation and measurement of various habitat factors. It would maintain a continuous review of the progress of ecology throughout the world and publish original ecological research findings from Britain and abroad. The cost of publishing full length monographs on vegetation would likely be beyond the means of the journal since, as Tansley pointed, out such lengthy works would also require substantial (primarily photographic) illustration. Nevertheless, it was soon clear that the prominence of photography, in ecological methods and in publication, would be maintained in this new context. The journal was quickly welcomed by other ecologists both in Britain and abroad. Reviewing the journal's first year, Henry Cowles in Chicago declared it "absolutely necessary reading for the working ecologist" and especially welcomed its unusual and "highly illuminating" practice of reproducing the illustrations from reviewed papers.[30]

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[27] Trail 1910.
[28] Tansley 1914a: 195.
[29] Tansley 1913a: 2.
[30] Cowles 1914: 438.

JOURNAL OF ECOLOGY VOL. I, PLATE 17

Photo *W. B. Crump*

Siliceous Grassland.
Facies of the common Rush (*Juncus effusus*).
Harvesting the rushes.

Photo. *W. B. Crump*

Calcareous Scrub and Grassland.
Rocky hill slope of Carboniferous Limestone.

MOSS—VEGETATION OF THE PEAK DISTRICT (pp. 275—285).

Fig. 4.6. W.B. Crump. *Vegetation of the Peak District.* From Tansley 1913b.

The supply of original research papers was uneven at first, but the journal reviewed much British and foreign vegetation work, and other publications of relevance to ecologists. Some former BVC members could be counted on for contributions, such as Frank Oliver who reported on his work in coastal habitats. As Cowles observed, when longer works were reviewed, it was considered important to include photographs from the original where possible. In a lengthy review of Charles Moss's primary survey work in the Peak District, for example, Tansley commented on the excellence of the photographic illustrations and reproduced eight of them, six as half-page plates and two full-page figures. All the photographs were by William Crump (Fig 4.6.). Similarly, a summary paper by Frank Elgee, drawing on his own pioneering work in the Yorkshire moorlands, included six plates (two of them full-page) from the book. Even when a journal review did not reproduce plates from the original work, the reviewer would commonly pass comment of the quality of its photographic illustrations.[31] Once established, the journal began to carry more sophisticated and confident autecological and synecological studies.[32] This increasing sophistication encompassed both ecological methods and the analysis of vegetation, and photography retained its place both as a field method and as a means of communicating the visual assessment of vegetation, its constituent species and habitat conditions. A 1915 paper on the moorland grass *Molinia* dealt both with the autecology of the species and its plant associations, combining vegetation maps with botanical drawings and numerous photographs. Freer opportunities for publication doubtless encouraged more work of a similar nature and reinforced the use of photographic methods for recording and reporting. Edward Salisbury's photographic collection, for example, dates largely from 1913, around the time he began to publish work, first in *New Phytologist* and the *Journal of Ecology* and then as a co-author of botanical text-books. His subsequent publishing career included further textbooks and semi-popular books on specialist topics in plant ecology, in which his photography played a prominent role.[33]

Although full monographs were reserved for book publishing, a dedicated ecological journal made it possible to publish more extended studies that could not be accommodated in more general botanical publications. These were often published in instalments from ongoing research findings, and almost always copiously illustrated with photographs. Work on the vegetation of the Brecklands of East Anglia by E. Pickworth Farrow, for example, was

[31] Oliver and Salisbury 1913a; Tansley 1913b; Elgee 1914; Tansley 1914b

[32] *Autecology* denotes study of the ecology of individual organisms, species or populations, as opposed to *synecology* which deals with communities of plants or animals and their environmental conditions.

[33] Jefferies 1915; Salisbury 1916, 1918; Fritsch and Salisbury 1914.

published in seven papers between 1915 and 1919, with a further paper drawing some general conclusions and theoretical implications in 1925. The series eventually ran to 132 pages, with 46 photographs, together with a variety of maps, charts and diagrams.[34] In another such extended series, beginning in 1922, Arthur Tansley and a former student Robert Adamson provided British ecology with a model intensive vegetation study from the chalk regions of southern England. The published study incorporated all the visual methods of vegetation study, including vegetation mapping, numerous detailed quadrat records, together with associated charts, photographs and detailed species (see Fig. 4.7). This was the ideal of vegetation description and analysis that Humboldt first envisaged a century earlier, incorporating visual and instrumental knowledge-making; data on the distribution and relative abundance of living organisms; physical data for a range of causal environmental parameters; structural or physiognomic descriptions of the vegetation under scrutiny and a range of visual representations to elucidate character analysis of the vegetation and environmental conditions, including sketch maps; quadrat charts; line diagrams, cross-sectional drawings and tabulated data. Photographs, unavailable to Humboldt, served to underpin the whole enterprise, authenticating the physical reality and visual appearance of the vegetation itself, and its scientific scrutiny by the ecological scientist.[35]

Confidence in ecology's place in the world beyond the sphere of botanical science was also evident as the journal became more established. When Frank Oliver collaborated with engineer, Alfred Carey, in a handbook on coastal land management,[36] Arthur Tansley praised it as "a pioneer example of the practical use to which the scientific study of ecology can be applied."[37] Once again, he praised the "excellent photographic plates and text diagrams which greatly add to the attractiveness and usefulness of the book", drawn from Oliver's coastal studies in southern England and France, with additions from the likes of Edith Cowles and Jean Massart, including photographs taken during the 1911 IPE. As the number of British ecologists grew, some inevitably moved away and took British vegetation study methods with them to new academic posts at colonial universities. One of the first members of the BVC,

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[34] Farrow 1915a *et seq*.

[35] Adamson 1922; Tansley 1922; Tansley and Adamson 1925, 1926. Field studies for the study commenced in 1912 and were completed in 1921, having suffered inevitable interruption during the Great War.

[36] Carey and Oliver 1918

[37] Tansley 1918: 159. Work of this kind foreshadowed one of ecology's more significant mid-twentieth century developments, the study of applied ecology and land management, for which the BES launched a separate journal in 1964.

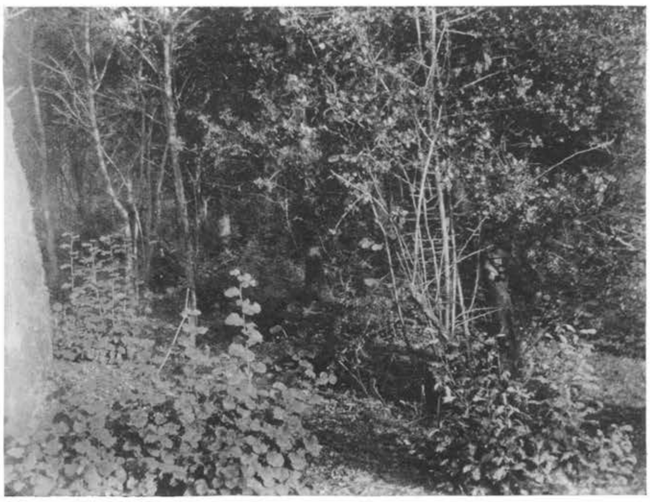
JOURNAL OF ECOLOGY VOL. IX, PLATE IX

Phot. R. S. A. Sept. 1913.

FIG. 1. "The Harrows." *Betula alba* and *Quercus robur* standards, *Corylus avellana* coppice—light phase, with *Senecio jacobaea* and *Cirsium palustre.*

Phot. A. G. Tansley, April 1921

FIG. 2. Glass's Brow Oak-hazel wood. *Quercus robur* standards (one in young leaf), *Corylus avellana* coppice, *Fagus silvatica* on slopes behind, *Taxus baccata* right foreground on chalk slope.



Phot. R. S. A. Sept. 1913

FIG. 3. Detail of FIG. 2. *Quercus robur* (trunk on left) and coppiced (right foreground), *Ilex aquifolium* (right), *Corylus avellana* coppiced (left foreground).

OAK-HAZEL WOODS

ADAMSON—WOODLANDS OF DITCHAM PARK

Fig. 4.7. R.S. Adamson. *Woodlands of Ditcham Park.* From Adamson 1922.

Francis Lewis, for example, left for Canada in 1912 and Robert Adamson for South Africa in 1923. Both continued ecological work in their new contexts and continued to publish in the *Journal of Ecology* with its typical illustrative profile, dominated by photographs of vegetation in the field.[38] As ecological studies became increasingly analytical and quantitative, by the late 1920s, reports incorporated much more data analysis, together with tabular and graphical presentations, as well as chart quadrats, cross-sectional drawings of topography and vegetation and, of course, photographs.[39]

In a further sign of growing ecological confidence, the journal also began to publish the first British attempts to integrate vegetation studies with investigations in animal ecology. Between 1921 and 1924, a series of Oxford University Expeditions to Spitsbergen and Bear Island was reported in the journal. Photography remained a central method for field recording and reporting, whether in plant or animal ecology. In practice, the habitat photography of primary surveys in animal ecology was almost indistinguishable from that of earlier vegetation surveys and fulfilled the same evidential and illustrative functions. This reflected the extension of the plant community concept to encompass animal as well as plant populations, together with the practical fact that most animals occupied habitats that were best differentiated by their vegetation cover. For the first time, however, the integrated study of plant and animal ecologies also combined photographs of plant communities with detailed photographic studies of animals (see Figs. 4.8-4.9).[40]

In general terms, the *Journal of Ecology* exerted considerable influence in standardising the methods and objects of ecological inquiry, and their representation. It continued to employ and promote photography, by example, as a critical tool, especially in for understanding plant associations and habitat characteristics. Even so, and for all ecology's increasing self-confidence, outside the still relatively small community of ecology addressed by the journal, the principles of plant association remained poorly understood. Even among

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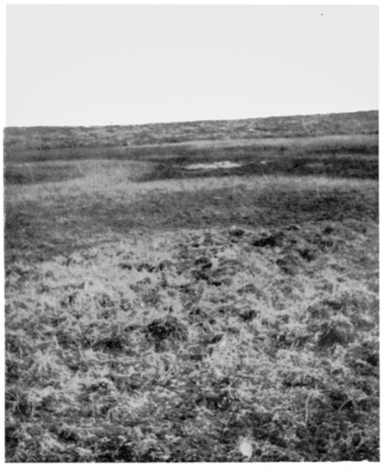
[38] For examples see Adamson 1927; Lewis *et al* 1928.

[39] Bracher 1929; Godwin 1929.

[40] Walton 1922; Summerhayes and Elton 1923, Summerhayes and Elton 1928. Previous work combining botanical and zoological work had extended no further than exhaustive natural history surveys of particular localities (eg. Praeger *et al* 1911-1915). In North America, animal ecology advanced more quickly than in Europe and some American studies had begun to apply the fundamental concepts of plant ecology, especially the notion of an ecological community and succession, to animals (Adams *et al* 1906, Adams *et al* 1909; Shelford 1911, 1913). Charles Elton, a central figure in the Oxford expeditions, is generally acknowledged as the founding figure of British animal ecology. His *Animal Ecology* was the first extended British account of the subject and laid out its first theoretical and methodological principles (Elton 1927). In 1932, Elton persuaded the BES to launch a second, independent *Journal of Animal Ecology*, which he edited until 1951.

ecologists such matters were not always clear. The recognition of plant communities, and of the need for vegetation survey and description, were widely accepted by 1920, when Edward Salisbury produced a standard mapping scheme for representing vegetation in black and white. But there remained considerable uncertainty about how communities should be recognised, described and represented. Over a decade later, Salisbury still felt compelled to write a paper outlining the basic requirements for adequate vegetation description, following the next year with a paper on standardising botanical nomenclature in ecological papers.[41] The only method of vegetation description that appeared unproblematic, and which was consistently applied by ecologists from the outset, was photography. As we shall shortly see, however, in the wider arena of vegetation study, which encompassed floristic phytogeographers as well as plant ecologists, that consistency was often less secure and indicated a continuing epistemological rift between the two perspectives on plant science. Ecological methods, whether photographic or otherwise, remained unpersuasive to a great many traditionally-minded taxonomists and morphological botanists.



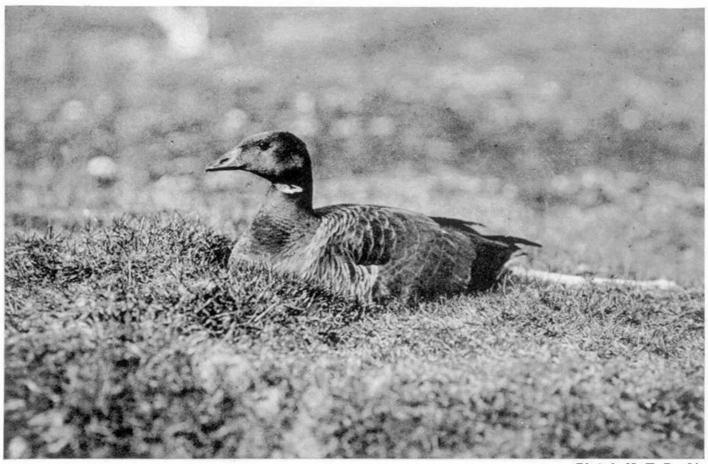


Fig.4.8. Charles Elton. *Wet tundra of Salix, Alopecurus etc., 1921.* From Summerhayes and Elton 1923.

Fig.4.9. A.N. T. Rankin. *Brent goose (Branta bernicla hrotah) on its nest, 1924.* From Summerhayes and Elton 1928.

Textbook photography

By the end of its first decade, in 1923, the British Ecological Society had grown at a modest but steady rate to a membership of 153, with a total *Journal* circulation in the region of 380 copies.[42] These were not huge numbers but the rate of growth had been sufficient to sustain and expand the size of the journal during that time. The audience reach of such a

[41] Salisbury 1920, 1931b, 1932.

[42] *J. Ecol.* 1924

journal was initially rather limited, extending only to those who already had a sympathetic interest in ecology. This was not the only audience in plant sciences, however, and during this decade ecologists also began to make a mark in the publication of botanical books, especially textbooks addressing the University and college curriculum.[43] Their texts contrasted, once again, both in content and in visual representation, with the standard works of established academic botany. Typical of the latter was Frederick Orpen Bower's *Botany of the Living Plant*, published in 1919. Bower's book was a standard text for University botany "framed on the lines of the annual Course of Elementary Lectures on Botany given in Glasgow University for more than thirty years." It contained no discussion of plant associations, or vegetation more generally, and made only dismissive, passing reference to ecology in its introduction. Indeed, Bower could see no point at all in the study of vegetation *en masse*. The "study of plants and of their vital activities cannot be carried out with success by merely examining the mass of Plants all together," he wrote. "They must be taken singly, and examined individually…arranged according to their characters. They must in fact be classified."[44] The book was liberally illustrated. Of its 548 pages, 380 contained one or more illustration, 200 of which had been prepared especially for the book and many others borrowed from elsewhere. Just 5 of them were from photographs, the rest were line drawings incorporated into the text. The book was published by Macmillan, a major commercial publisher.

By contrast, the first British book on ecology, which had been published in 1911, was a specialist publication under the Cambridge University Press, and expected barely to cover its costs. Nevertheless, its 368 pages incorporated 65 photographs, printed on coated paper, in 36 photographic plates, together with several maps, diagrams, sketches, and two long fold-out drawings. The book was *Types of British Vegetation*, the work which seemed so to puzzle Yorkshire botanist Frederick Arnold Lees in his review for *The Naturalist.*[45] Prepared and published in advance of the British IPE of 1911, *Types* was both an extended guide for IPE excursionists and a conspectus of British vegetation. It drew together all the ecological research on British vegetation to date and, after the IPE, remained a text of lasting influence

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[43] There was also an enormous readership for books of popular botany and natural history. In this fledgling phase of its existence, ecology was hardly yet equipped to tackle the expectations and biological assumptions of this market. For a history of British natural history books, see Allen 2010 and, for the *New Naturalists* series, Marren 1995.

[44] Bower 1919: vii, 1.

[45] Tansley *et al* 1911a; Lees 1912: 11 (see *Amateur associations*, chapter 3); Allen 2010: 407; Tansley 1939: v, at publication it was sold at 6/- each (A.G. Tansley to T.W. Woodhead, 14 October 1911. Woodhead Collection, Tolson Memorial Museum, Huddersfield).

in British ecology.[46] The first monograph on British plant associations, *Types was* a collaboration between several members of the British Vegetation Committee, each writing chapters on the plant communities and habitats in which they had undertaken close studies. Tansley wrote significant parts of the book and edited the overall volume. The book drew together the results of pioneering studies, and made a first attempt at a broad classification of vegetation types for Britain as a whole. It also confirmed and reinforced the standard methods for vegetation study that had been developed over the previous decade, chiefly in the work and deliberations of the British Vegetation Committee. The uses of photography, as we saw in the previous chapter, were prominent in those deliberations and, though rarely spoken in methodological terms, remained in tacit consensus as a central component of ecological field-study and its reporting.

Unlike Frederick Bower's botanical figures, photographs for ecologists were not simple illustrations. They were primary evidence, and corroboration for the ecological witness of real instances of the plant associations described. Moreover, they were expected to bear scrutiny, to yield further evidence of the detailed character and conditions of the particular stands of vegetation delineated in text and image. When Tansley included photographs to describe the conditions of shade in an oakwood, the photographs were to be understood not as illustrations for a general principle but as guarantors that the conditions described were really present in particular woods. The evidence was directly available for examination by the reader, as if she had been present at the time the photograph was taken (Fig. 4.10 overleaf). Plate I shows not two photographs but two woods, each under different canopy cover, the understorey vegetation displaying the effects of the resulting conditions of shade and light. Captions anchor the specificity of the photograph further, identifying the woods by name, and providing information on the primary species present, and the underlying geology. Importantly, in many cases the individual species mentioned can be reliably identified from the photographs. Text, in turn, reinforced the evidential weight of the photograph by supplying further particulars of vegetation physiognomy, site conditions and detailed species data. This combination of visual evidence, description and data is one we have seen before, in

[46] Even in the most recent effort to shape a classification for British Plant Communities, John Rodwell wrote: "It is a tribute to the insight of our early ecologists that we can still return with profit to Types of British Vegetation…as the first coordinated attempt to recognise and describe different kinds of plant community in this country." (Rodwell 1991: 3).

PLATE I

Phot. S. Mangham

a. *Quercus Robur* (in close canopy). *Corylus Avellana*, *Cratægus monogyna*, *Rubus* spp., *Pteris aquilina*, *Digitalis purpurea*. Staffhurst Wood, Surrey, on Weald clay.

Phot. S. Mangham

b. Oak-hazel wood; oaks in open canopy. *Corylus Avellana* (second year coppice), *Cnicus palustris*, *Euphorbia amygdaloides*, *Teucrium Scorodonia*, *Pteris aquilina*. Chevening Park, Kent, on clay-with-flints.

Pedunculate oakwood association (*Quercetum Roburis*).

Fig. 4.10. S. Mangham. *Oak woods.* From Tansley *et al.* 1911a.

Humboldt's tableaux of Mount Chimborazo, and in the vegetation surveys of the Smith brothers. By 1911, it had become a standard combination for British vegetation survey and was applied consistently for all the vegetation types described in this book, from the birchwoods of the Scottish Highlands to the fens of Norfolk.

Photographs were also supplemented by other graphical arguments, where particular ecological relationships required elucidation. These included maps, charts and occasional diagrams and, most notably, cross-sectional drawings to show the zonation of vegetation along an environmental gradient (Fig. 4.11 overleaf). The technique was first used in 1908, by Richard Yapp, to sketch generalised relationships between different elements of the vegetation and soil water levels at Wicken Fen.[47] In *Types*, Marietta Pallis presented her cross-section as direct and specific evidence of these relationships from plants recorded along a transect in a particular location, at Barton Broad in Norfolk. Divided into six sections, the drawing describes a series of vegetation zones, from dry agricultural land, through fen and reedswamp, to floating aquatic vegetation and open water. The figure's geographical specificity and scientific content is augmented by the suggestion that it has been drawn to scale, albeit approximately, and by annotation with the names of species recorded in the various zones. The epistemological weight of the drawing is further underpinned by the character of its graphic components, which have been drawn to resemble the varied growth forms of the plants recorded along the transect, forms which other ecologists would recognise as associated with the environmental conditions described.[48] Like the other sections of the book, Pallis's account of the vegetation of the Broads also drew on photographic evidence, reinforcing her graphical and textual accounts with further visual detail from particular plots of vegetation (Fig. 4.12 overleaf). In epistemological terms, the photographs and cross-section here operate in similar ways, to provide specific, detailed information about particular places and types of vegetation. Both are anchored by caption and text, as reciprocal evidence for the plant associations described. Crucially, both represent vegetation in ways that other ecologists would recognise as visually analogous to field experience, to what they would see with their own eyes were they to visit these places themselves. In this case, they did just that, since Pallis's field-sites occupied a significant place in the itinerary of the British IPE.

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[47] Yapp 1908.

[48] For further consideration of the relationship between graphical forms and visual field methods in ecology, see *Sketching knowledge* in chapter 5.

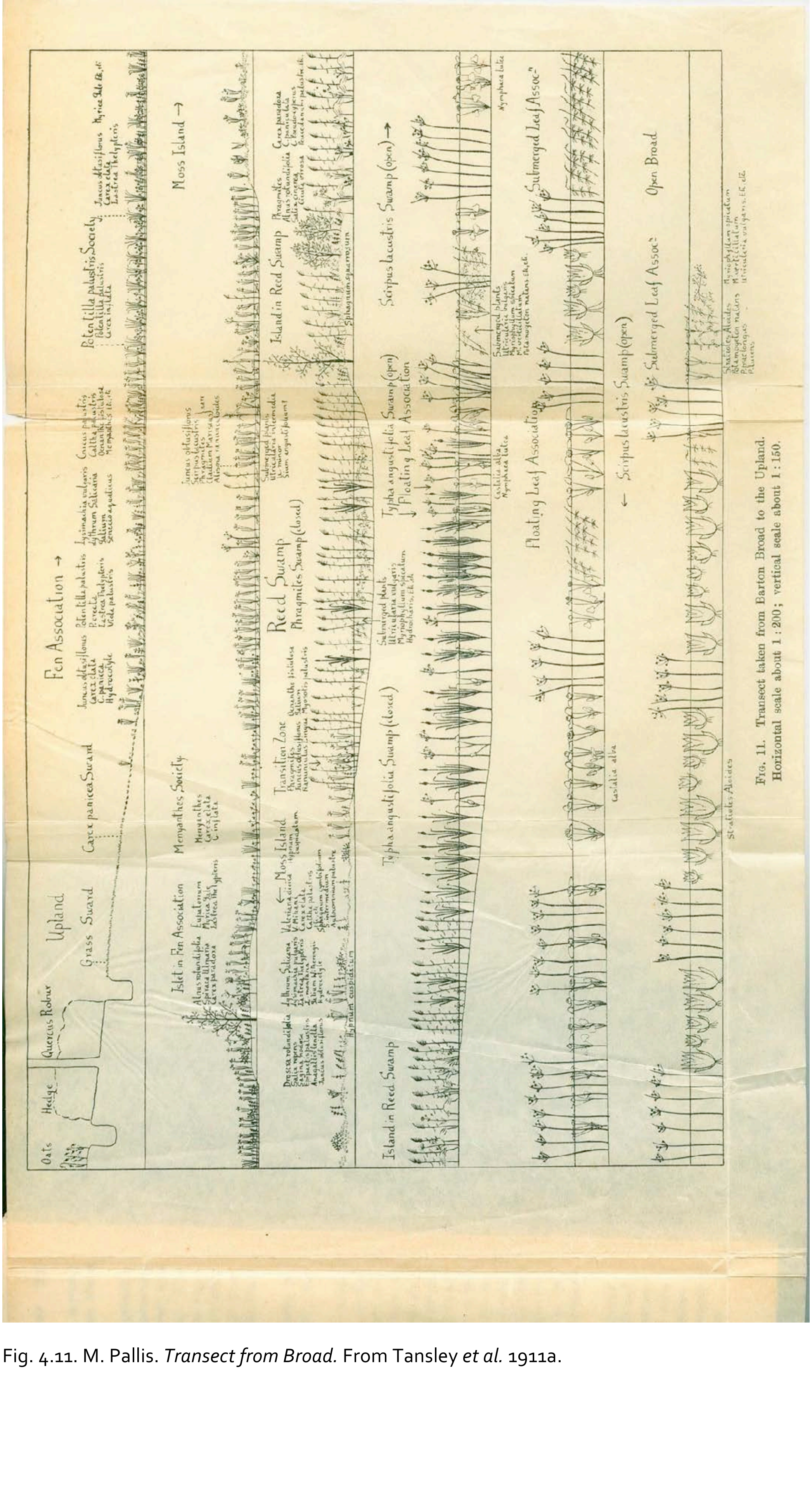

Fig. 4.11. M. Pallis. *Transect from Broad.* From Tansley *et al.* 1911a.

PLATE XXII

Phot. M. Pallis

a. Open reed swamp association: *Scirpus lacustris* and *Castalia alba*. The dark line in the background is fen association. Sutton Broad.

Phot. M. Pallis

b. Detail of fen association: *Phragmites vulgaris*, *Juncus subnodulosus*, *Lastrea Thelypteris*, *Helleborine longifolia* (*Epipactis palustris*), *Lysimachia vulgaris*, etc.

Aquatic and Fen formations.

Fig. 4.12. M. Pallis. *Vegetation of the Norfolk Broads.* From Tansley *et al.* 1911a.

The immediate purpose of *Types* was as a guide book for visiting ecological botanists and the book was not expected to colonise the reading habits of a wider botanical audience to any significant degree. Such a colonisation would require an ecological perspective in more general botanical texts and in the college curriculum. Where ecologists occupied academic posts, ecology made some inroads into their teaching, but very few had real influence over the shape of the curriculum. Elsewhere, college and University teaching remained pretty well undisturbed by ecologists' revolutionary aspirations. In botanical textbooks, ecologists did make some inroads, producing books which sold sufficiently well to warrant multiple editions and reprints. In such a context, ecologists felt constrained to cover the conventional morphological ground of botanical teaching but sought also to present an approach that was at one more physiological and more ecological, treating the subject from the perspective of plants as whole organisms, and including sections on the study of the soil and other environmental influences to which plants were subject. The aim was "to give the student a broader outlook on his subject...[and]...to relieve the tedium of mere description by relating form and structure to the functions served."[49] From this perspective, the study of plants as interacting components within larger plant associations or vegetation could be presented as a natural progression in the broader study of plant life. Such texts generally treated plant communities towards the end of the book, introducing botanical study first through more familiar territory, but this also had the effect of presenting vegetation as the natural culmination of all other kinds of botanical study. Whereas most existing botany textbooks drew frequently for illustration on non-British species and horticultural examples, the authors of ecologically-oriented botany texts also emphasised the usefulness of common British plants, growing in their natural habitats, as examples for study. This also facilitated progress towards the discussion of vegetation, by referencing familiar species and habitats, and providing appropriate photographic examples in the manner of *Types of British Vegetation. An Introduction to the Study of Plants*, by Felix Fristch and E.J. Salisbury provided an early model for this kind of text, incorporating a substantial section devoted to vegetation towards the end of the book. Forty-two pages of text were illustrated with 23 pictures, entirely from photographs by Salisbury. Following the format of *Types*, most were printed as separate plates on coated paper, reflecting one again the value placed by ecologists on visual record and specific photographic example.[50]

[49] Fritsch and Salisbury 1914: v.
[50] Ibid.

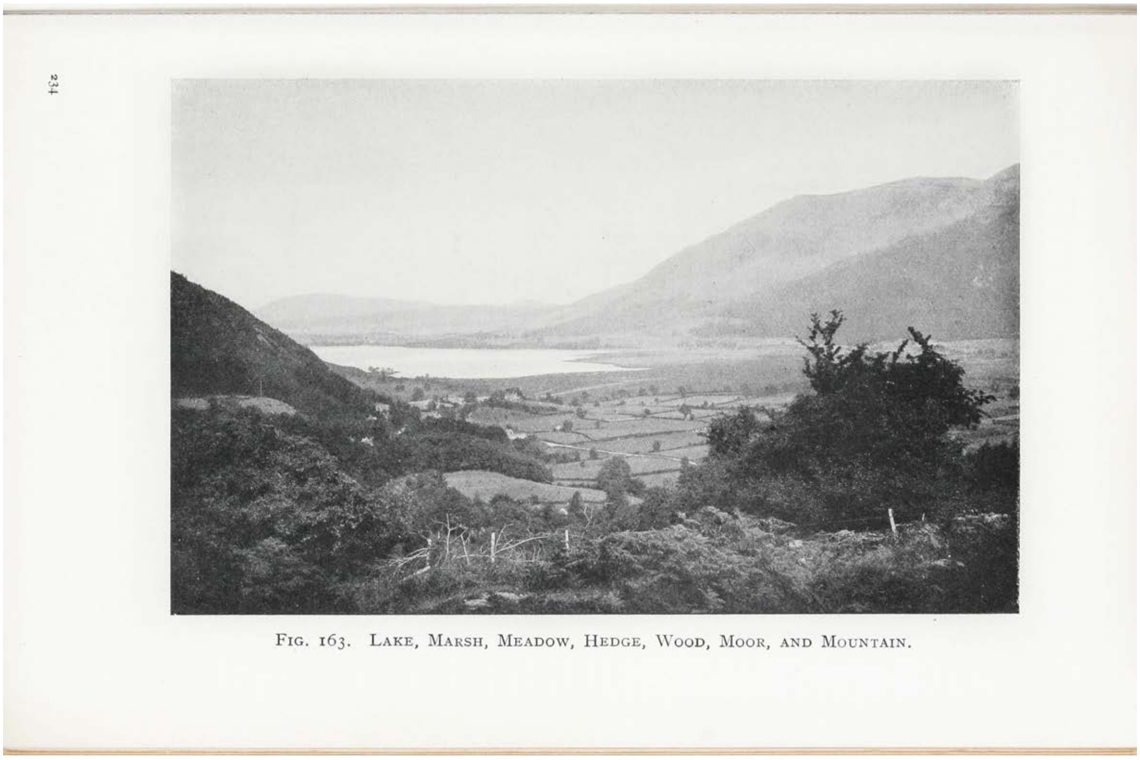

Fig. 4.13. *Lake, Marsh, Meadow, Hedge, Wood, Moor, and Mountain.* From Woodhead 1915.

Fritsch and Salisbury's book was written for matriculating and first-year undergraduate botanists at University. The following year, Thomas Woodhead published an equivalent text for senior schools and colleges. To meet the needs of the prevailing syllabus, Woodhead's text followed a more overtly morphological approach in the early sections of his book, whilst emphasising the functional significance of form. For these sections, he relied heavily on photomicrographs for illustration, in addition to the customary line drawings of most botanical texts. Wherever possible, he also used photographs of actual plants, many of them growing in natural conditions, to illustrate form and structure. He also included a section on plant classification, the accustomed territory of floristic botany, but was careful to preface the section with a photograph showing a range of vegetation types within a general landscape context (Fig. 4.13). In studying the vegetation of a district, he said, it is "more interesting and profitable to devote your attention to the plants of one habitat at a time, than to collect plants indiscriminately."[51] The botany student should study common species first, he wrote, to determine their associations with one another and with their habitat conditions. Nearly a quarter of the book was devoted directly to vegetation study, with numerous photographs, in

[51] Woodhead 1915: 233.

both full and half plates, to assist the student in recognising and understanding the right plant associations.

Like much early ecological writing, whether in journals or in books, these texts were intended to win recognition for the real existence of plant communities, and for plants and animals as environmentally responsive (that is, ecological) organisms, rather than mere taxonomic units. The recognition of objects of legitimate study is a fundamental requirement for the successful establishment of a new scientific discipline and photographs were prominent in such texts because ecologists naturally assumed that photographic representation would provide a mechanically objective guarantee for vegetation and its plant communities as real objects. The visual authentication and description of plant communities by an ecologist, using photographs, maps and other forms of data presentation, in turn answered to a second requirement for establishing a new science, the recognition of a body of fundamental concepts or coherent theoretical framework. The systematic recognition of related *Types of British Vegetation* provided a classificatory structure for vegetation science, whilst photographs authenticated its constituent plant communities. At the same time, photographs reified ecological concepts, such as association, zonation, succession and related processes. Pallis's cross-sectional drawings, combined with photographs, provided compelling visual evidence for all these concepts, as well as for the plant associations themselves.

A third requirement for a new science is the development of a methodological framework proper to the study of its objects. Ecologists also began, accordingly, to publish texts meeting this requirement. American ecologist Frederic Clements published *Research Methods in Ecology* in 1905 and provided ecology with its first statement of methodological principles, together with a comprehensive set of practical methods. *Research Methods* underlined ecology as a science of the field, supported by a wide range of instrumental practices for environmental measurement, as well as methods for survey and detailed vegetation study. Clements' work was so well received, especially in Britain, that the first British textbook of ecological methods did not appear until 1923, with Arthur Tansley's *Practical Plant Ecology*. The visual basis for ecological study was evident in such texts, which gave considerable prominence to methods for turning visual observation into rational inscription, in both numerical and graphical terms. Both Clements and Tansley gave explicit sanction to photographic methods, and provided instruction on their proper use in ecology. Clements, in particular, presented photography, alongside mapping and other observational practices, as central to ecological method.[52]

It would be easy from this review of the print cultures of British ecology to assume that clear waters everywhere separated ecology from established botany; that photography, in particular, provided an unambiguous visual account of the difference between the two. Ecologists deployed photographs to describe plant communities, association and environmental process, whilst botanical illustration described plant species and their varied forms, as taxonomic and morphological units. The distinction is certainly at its clearest in placing ecology as vegetation science against an academic botany dominated by plant morphology, and perhaps particularly so in a British context. It was a simple, if difficult, matter of obtaining recognition for plant communities and field study as worthy of attention from botanists trained in plant dissection and laboratory practice. The distinction was less clear, however, in the context of floristic phytogeography, which shared ecology's interests in whole plants and their distribution. The BAAS botanical photographs collection was a casualty of the resulting epistemological confusion, in which floristic botanists continued established practices of counting species and mapping their distribution, whilst ecologists tried to persuade them to look differently at plants, as components within higher order units of organisation, not in taxonomic arrangements but in plant associations and communities. Even amongst ecologists, plant associations were not always evident at first sight. In his Presidential address to the BES in 1923, Irish botanist Robert Lloyd Praeger, for one, recalled considerable uncertainty as to the very existence of plant associations when first beginning vegetation survey in 1905. It was through the exchange of experience in the British Vegetation Committee, together with his own field study, that Praeger was persuaded of their reality.[53] Nor were true plant associations always easy to discern without adequate training. Both Clements and Tansley complained of a proliferation of spurious plant communities, derived from "lists of species, often incorrectly determined, representing badly defined and incorrectly apprehended vegetation units, which often indeed have no real existence."[54]

This difficulty was especially evident in the context of European phytogeography, where a floristic approach maintained a stronger hold on geographical botanists, even as they

[52] Clements 1905; Tansley 1923. These methods and texts receive detailed discussion in the following chapter.

[53] Praeger 1923.

[54] Tansley 1914a: 196. See Hagen 1986 for further discussion of the competing notions of plant geography based on taxonomic and ecological lines.

developed a common conception of the plant community with British and American ecologists. A number of European ecologists drew a sharp division between the two perspectives. Jean Massart, in Belgium, for example, took a position very similar to that of British ecologists in emphasising a clear distinction between floristic and ecological botany.[55] Others, like E.J. Salisbury, found little enough difficulty in reconciling the two approaches. Still others, however, continued in some confusion. The resulting ambivalence is particularly evident in a number of publishing projects which sought to take a broad perspective on vegetation science, between the late 1890s and the 1920s, all of which used photographs as a primary method for representing vegetation.

Die Vegetation der Erde

The first of these was a series of series of monographs on the vegetation of different regions, under the general title of *Die Vegetation der Erde*. Adolf Engler and Oscar Drude, Professors of Botany at Berlin and Dresden respectively, were its general editors, and also authors of selected volumes. Engler and Drude both enjoyed international reputations as phytogeographers. Drude had previously published an influential botanical atlas, dividing the globe into 'floristic realms' and 'vegetation zones'. Engler, the most influential German systematic botanist of his generation, had produced a new system of botanical classification; he also went on to describe a new geographical classification for plant distributions, defining distinct phytogeographical regions and districts.[56] The remainder were devolved to other botanists with particular expertise in their subject regions. The volumes were mostly in German, with notable exceptions in English for monographs on the vegetation of North America and New Zealand. Publication spanned nearly three decades, from 1896 to 1923, consisting of 15 volumes, though Engler's contributions on African vegetation finally expanded to five separate volumes. Each volume was published beneath a preface from the general editors, indicating their intent treat vegetation both physiognomically and floristically, but leaving much to the discretion of individual authors to decide how to present or describe particular regions.

The general aim for each volume was to provide an account of the general vegetation formations of the region, separated into distinct sub-groups or associations, based on floristic character and topographic variation, together with an account of the chief forms of plant

[55] Massart 1910a: 1
[56] Drude 1887; Engler 1899, 1903. For more on Drude's cartographic botany, see *Scaling the view* in the next chapter.

growth (forest trees, grasses and so on). The division of general formations into distinctive plant associations, the series editors made clear, was to be applied chiefly to European floras, where much more was known about the detailed differences between districts. In the early volumes, even in European districts, most of the authors lacked the requisite knowledge of a region's vegetation, as opposed to its flora. They were unaccustomed to seeing and describing a district's flora in this way and many reverted to conventional floristic accounts, with synoptic sketches of the region from the perspective of systematic botany. These often amounted to little more than aggregated species accounts, detailing the number of species and genera represented, and sometimes including extended species lists, often drawn from collections rather than original fieldwork.[57] Illustrations were sparse and were mostly printed from woodcuts and line drawings. The few photographs in evidence were usually generic landscape images of dramatic mountain scenes or exotic vegetation. Some made rudimentary efforts to describe plant associations but mostly they retained a strong focus on individual species, and a strong interest in endemism and the geographical limits of particular species. These were the hallmarks of the floristic and systematic botany practiced by Hooker and other 19th century geographical botanists. It was hardly vegetation analysis as envisaged by Tansley and the other members of the British Vegetation Committee.

As the series progressed, plant communities made a better showing and, as they did so, each volume also began to include more photographic illustrations.[58] In his Foreword to his 1903 contribution, Drude made a deliberate attempt to distinguish his from previous volumes, as properly concerned with plant communities and biological conditions, not merely floristic accounts.[59] Nevertheless, the series continued with an ambivalent stance towards the description and representation of vegetation. Photographic illustrations included images of generalised vegetation formations and images dominated by particular species. Few could readily be assigned to more definite plant associations. Even when floristic accounts gave way to plant associations, ecological descriptions were frequently undermined by a preponderance of photographs of specimen trees or other notable species (Fig. 4.14). When reviewing the

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[57] Engler and Drude 1896.

[58] Exceptionally, the first of the volumes to provide a truly ecological account of detailed plant community composition and structure, together with habitat conditions considered at a local level contained no illustrations whatever. It was an account of the heathlands of northern Germany, by Paul Graebner (1901), the German translator of Eugene Warming's *Plantesamfund*.

[59] Drude 1902.

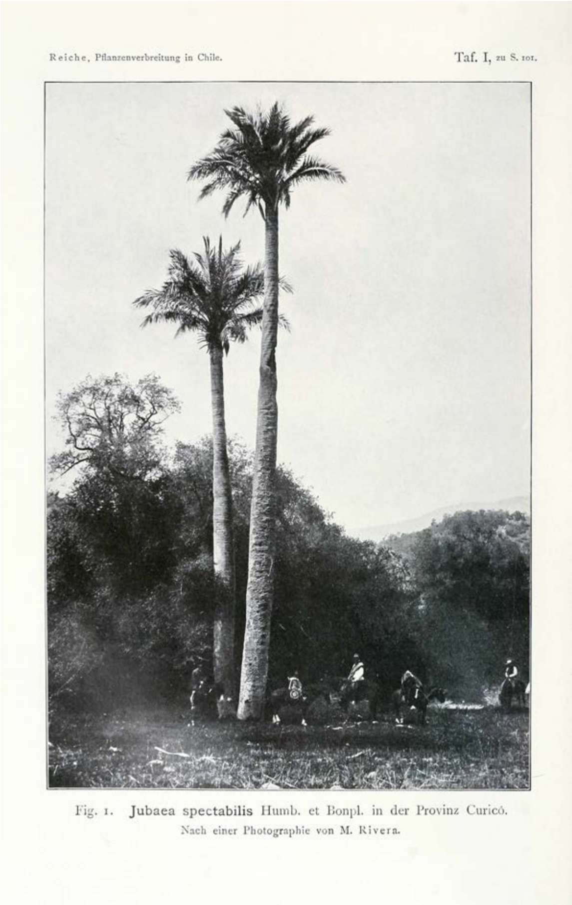

Fig.4.14 M. Rivera *Jubaea spectabilis.* Undated. From Diels 1906

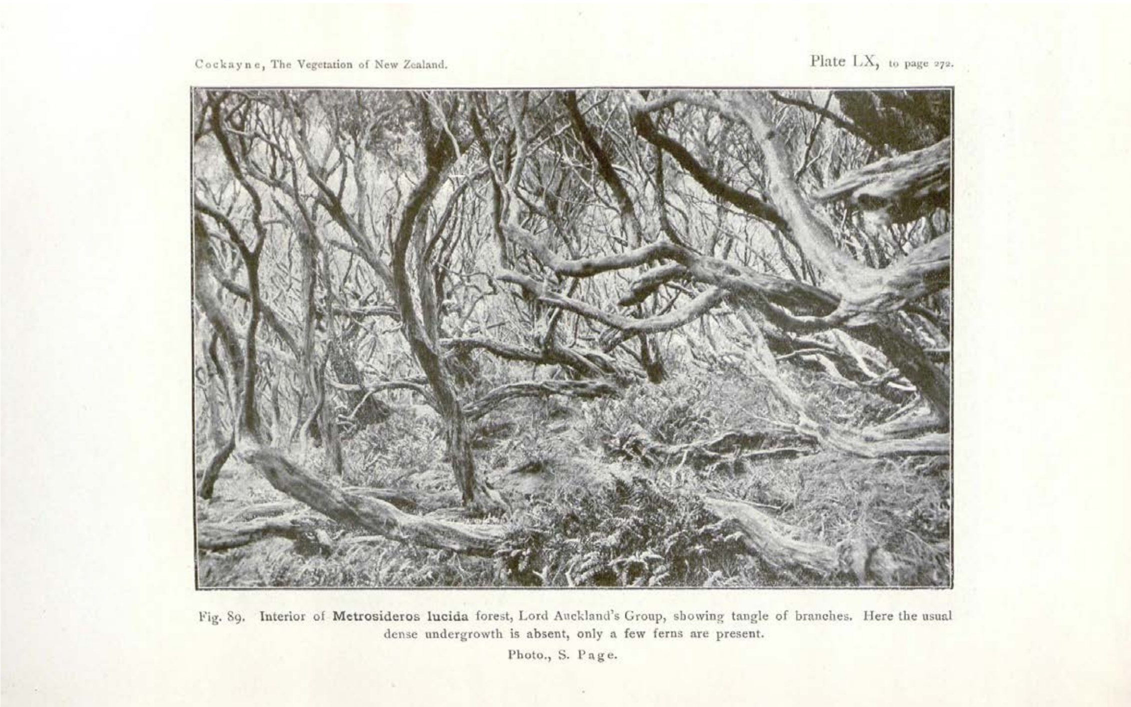

Fig.4.15 L. Cockayne *Interior of Metrosideros lucida forest.* c.1910. From Cockayne 1921.

state of British botanical survey in 1912, William Smith, still referred readers to Engler and Drude's series as "outstanding examples of floristic plant-geography."[60]

A marked contrast to the series in general was provided by Leonard Cockayne, on the vegetation of New Zealand. Cockayne was already a recognised authority on the colony's flora when Engler commissioned the monograph in 1904 but he decided that its plant communities were too poorly known and embarked on almost a decade of original survey work. The result, which was significantly delayed by the Great War, emerged in print only in 1921. It was the fullest ecological and phytosociological account of vegetation in the series.[61] Cockayne followed Engler and Drude's format scrupulously. Unlike other authors, however, who gave floristic statistics for whole districts or regions, he included statistics for plant families, genera and species, for each type of vegetation. He also gave accounts of the dominant plants, their growth-forms and biology, for each vegetation formation, before proceeding to a detailed account of plant associations and their ecological relations. The volume was also the most profusely illustrated with photographs, providing a comprehensive visual account of the vegetation types described in the text. Photographic subjects included both vegetation and characteristic species but Cockayne's discussions of individual species were always framed in ecological terms, in relation to habitat conditions and plant associations. In total, the volume incorporated 95 photographs, almost half of them as full-page plates (Fig. 4.15). The first volume in the series had contained just 25 illustrations, including only two photographs, within a text that amounted to little more than an aggregated species account.[62] The proliferation of photographic illustrations in later volumes in the series reflected a developing practice amongst ecologically minded botanists more widely in the first decade of the 20th century. However, most of the volumes in Engler and Drude's ambitious project, and the series taken as a whole, presented a confused picture of vegetation study. Its ambivalent treatment of vegetation in a context of floristic accounting revealed considerable uncertainty regarding the status of plant communities among contributing authors. The consequent epistemological confusion was evident in the photographic strategies adopted by many of those authors for representing the various kinds of vegetation they professed to describe.

[60] Smith 1912: 54.
[61] Cockayne 1921.
[62] Willkomm 1896.

Vegetationsbilder

Ambivalence regarding plant communities, and their uncertain articulation in photography, were not confined to Engler and Drude's contributing authors. In 1903, two other German botanical professors, George Karsten (1863-1937) and Heinrich Schenck (1860-1927) began an equally ambitious project. Published in 26 series over 30 years, *Vegetationsbilder* aimed to make a photographic collection of all the world's vegetation.[63] Each series consisted of eight separate issues, published in loose-bound volumes containing between 6 and 12 fine collotype prints, separated by leaves of protective tissue from accompanying descriptive texts. Like Engler and Drude's series, the texts and photographs were drawn from travelling botanists with particular experience in the regions under examination. In most cases, the text authors also contributed photographs for their own accounts. Karsten and Schenck were themselves responsible for several of the early issues. The series was intended to remedy what they saw as a general lack of useful images for University lectures on phytogeography, providing reliable impressions of the physiognomy of different kinds of vegetation. Printed on plates measuring approximately 31cm x 24cm, with an image size of around 22cm x 16cm, the photographs were intended for close scrutiny, to be circulated among students during lectures.

From the very first issue, the photographs indicated a problematic and confused epistemological relationship between the concept of the plant species and the vegetation community. The audience for the work was expected to include both botanists and geographers but the editors also expected their efforts to be of value "in all circles that are devoted to colonial efforts." In addition to capturing all the earth's "different types of plant formations and associations", therefore, they would provide useful images of, capturing the appearances of the most characteristic plant species and of "important foreign crops".[64] The resulting selection of images was mixed, sometimes including general vegetation views, but most often focussed on individual species, with a particular preponderance of trees. This photographic ambivalence was not clarified by the accompanying texts, which were themselves highly variable. Some authors offered accounts heavily weighted towards morphological description of dominant species or growth forms. Arguably, such an emphasis reflected a physiognomic tradition of vegetation description reaching back to Humboldt, but it was hardly in keeping with a modern ecological emphasis on plant associations, their

[63] Karsten and Schenck 1903-1933
[64] Ibid.: 'Ankündigung'

species composition and habitat conditions. Some authors did describe assemblages of species for particular locations (if not actual plant associations), and commented on ecological relationships, both biotic (for example, the effects of leaf-cutter ants) and abiotic (soils, rainfall, water etc.) This kind of commentary was a feature of some of Karsten's own early contributions. Nevertheless, Karsten's images frequently betrayed greater interest in individual species — exotic species, rarities, and plants of economic value — than in their encompassing vegetation. His images were often annotated to identify accompanying species but any consideration of relevant plant associations from such images was subverted by the visual prominence given to one or two primary species (Fig. 4.16). In some cases, individual photographs not only fail to register the fundamental characteristic of plant communities, they also reveal aesthetic motivations that threaten to overwhelm botanical or ecological representation.

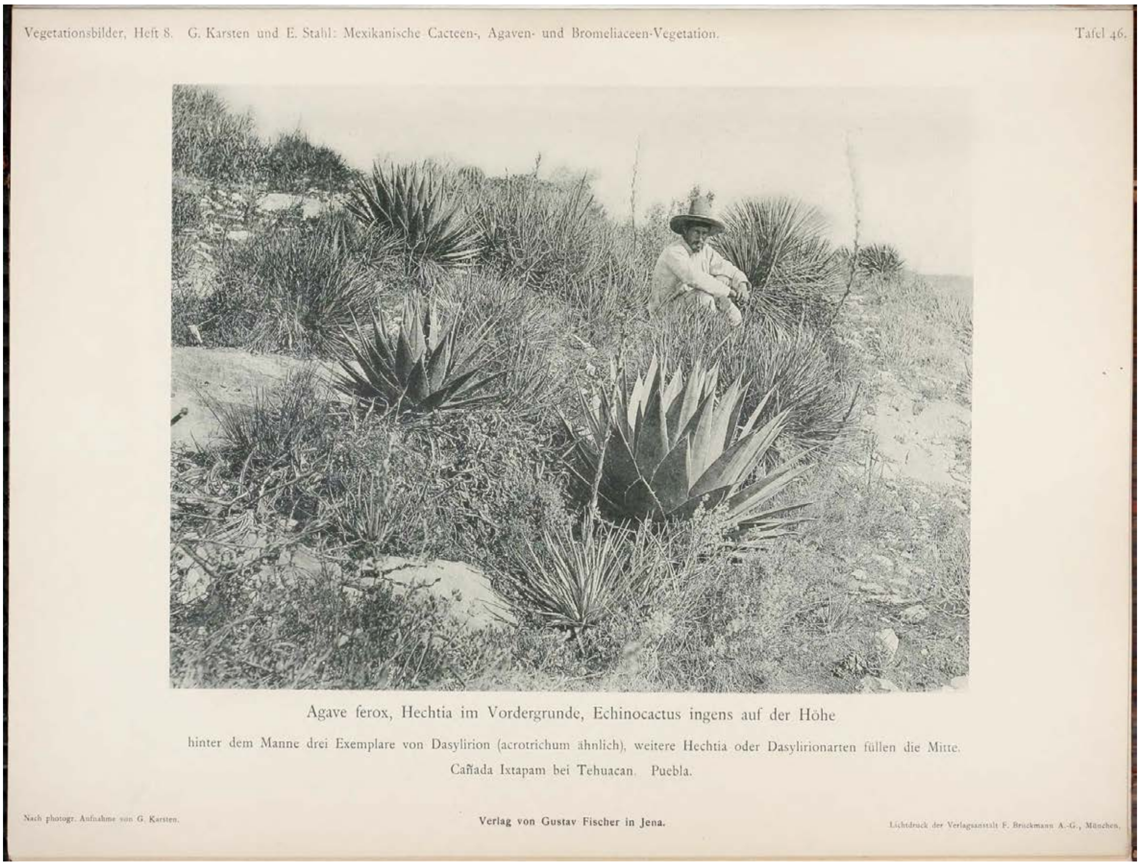

Fig.4.16. G. Karsten *Agave ferox.* From Karsten and Stahl 1903, plate 46.

In Karsten's plate 46 from the 1903 series, for example, he placed a local helper for scale. Pictured with several Agave plants in a receding arrangement (closely constructed on the golden section), the result was an image with pictorial depth and a pleasing harmonious composition. Botanically, the effect was to give visual prominence and scientific direction to a particular species, at the expense of its associated vegetation. Many of the photographs included in earlier volumes were taken before the concept of the plant association was clearly articulated or widely known. Using such images, illustration could hardly be expected successfully to represent vegetation from an ecological point of view. As the series progressed, however, written accounts were more likely to incorporate ecological commentary and, in the work of particular authors, the character of the photographs used to illustrate vegetation changed accordingly. In 1909, for example, issues 1 and 2 featured sophisticated and detailed descriptions of plant community composition and structure, by Adolf Ernst, on the volcanic forest vegetation of Java and Sumatra, in marked contrast to earlier contributions from other authors on the same region in 1905, which laid particular emphasis on a range of economically valuable species such as teak, a horticulturally attractive floating lotus and bamboo forests cleared for coffee plantations.

Fig.4.17 O. Feucht *Hochmoor auf dem Vogelskopf, 1908.* From Feucht 1909, plate 13.

In the same year, issue 3 carried an account of Black Forest vegetation types by Otto Feucht, and Issue 4, a description of a Dalmatian lake and its lakeside vegetation, by L. Adamovic. In both cases, the photographs consisted mostly of general views of plant communities, with occasional closer views designed to reveal detailed vegetation structure and composition, rather than particular species of note (Fig. 4.17).[65]

A similar disparity between different contributions was still evident at least ten years after the first series. In 1913, in an issue on the vegetation of the Western Caucasus, for example, Swiss botanists Martin Rikli and Eduard Rübel, identified each of their photographs with particular excursions, together with full descriptions of the structure and species-composition of the vegetation shown in the photographs. Each image and its associated text carried the specific date and location of survey. Only two years previously, George Karsten devoted a whole issue to pictures of the coniferous trees of California. Both text and image offered little pretence at vegetation description, dealing entirely with woody species. The photographs consisted entirely of specimen portraits of mature trees, their accompanying texts limited to discussions of species morphology.[66] For Rikli and Rübel, the purpose of ecological photography was to identify and describe particular stands of vegetation. Karsten's pictures were portraits of specimen trees and, like all type specimens, intended to stand in for all trees of their kind, without reference to their immediate context within a plant community. By placing all these issues within a single series, the editors of *Vegetationsbilder* displayed an ambivalent and epistemologically confused approach to vegetation and its description.

Flora photographica

Vegetationsbilder was a highly successful series and, together with Engler and Drude's *Vegetation der Erde* exerted a considerable influence on how botanists understood the appearance and nature of vegetation. Both are still widely, if infrequently, referenced by botanists and plant ecologists today. The model of phytogeography and photographic description on display in these two major works was also the immediate inspiration for a further ambitious project which, like *Vegetationsbilder,* aspired to describe the vegetation of the entire world, 'by the art of photography'.

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[65] Ernst 1909; Büsgen *et al* 1905; Feucht 1909; Adamovic 1909.
[66] Rikli and Rübel 1913: pl. 6-7; Karsten 1911: pl. 1.

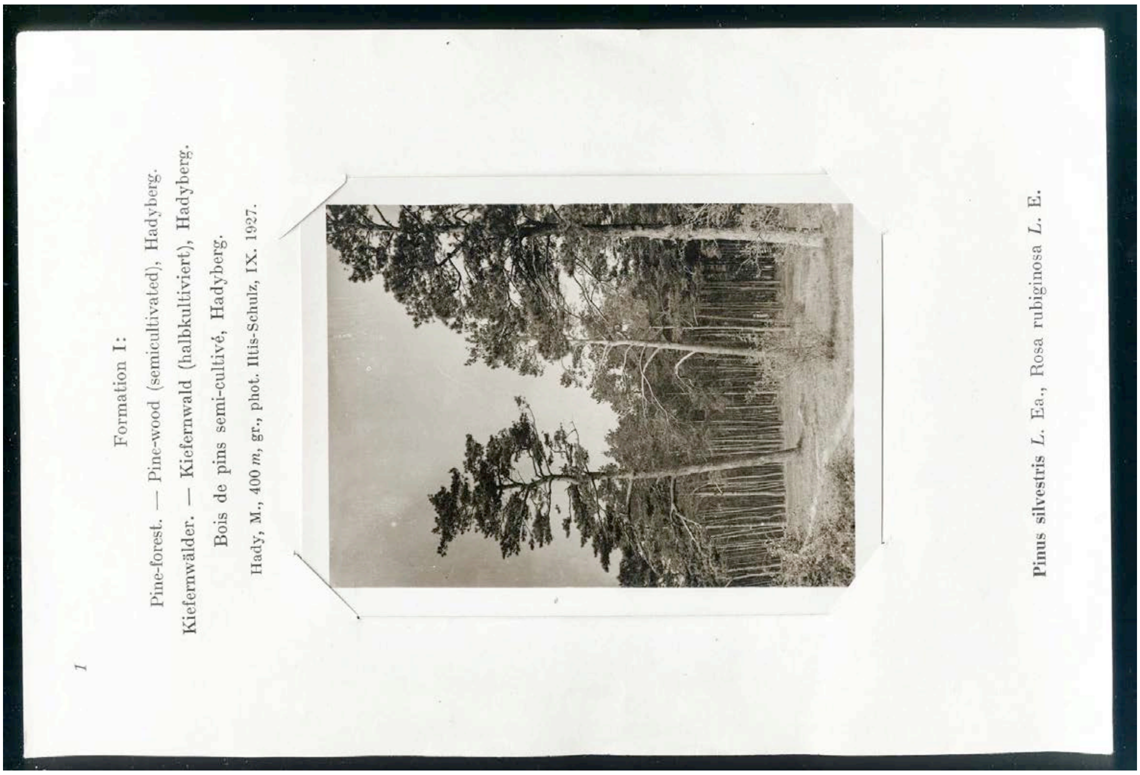
Fig.4.18. *Flora Photographica II: Europa Media.* Iltis and Schulz 1928.

For more than 20 years, Czech botanist Hugo Iltis had been photographing in his native Moravia, with the intention of publishing a photographic guide to the plants and vegetation of the district. In the mid-1920s, his ambitions expanded considerably, as he began to prepare material for the first volume of a project under the grandiose title of *Totius Orbis Flora Photographica Arte Depicta.* In order to encompass all the world's vegetation, he proposed a total of 29 volumes, each containing photographs of the vegetation types of to be found in each of Engler's phytogeographical regions and districts, with explanatory texts by relevant expert botanists. The whole work would be issued in German, French and English editions. The photographs were to be published as original silver gelatin prints, 100 for each volume, corner-mounted into separate sheets of paper, contained in a cloth-bound box and accompanied by a soft-bound text volume (Fig. 4.18). It was a format Iltis hoped would be valuable to researchers, but was primarily designed to facilitate use in an educational setting, in particular through the use of an epidiascope, a precursor to the overhead projector. The separate pages could also be passed hand-to-hand and the loose mounted photographs could be readily replaced by new prints as necessary. Similarly, new sheets and photographs could be added if it proved necessary to describe additional kinds of vegetation. In the event, only two of the projected volumes were produced before Iltis's publisher went out of business in 1933, but the scale and intent of the project is clear.[67]

Iltis made no mention of the earlier project but clearly *Flora Photographica* shared much common ground with *Vegetetationsbilder*. It differed, however, in its use of original photographs, rather than the photo-mechanical prints of the earlier series. The use of original photographic prints was a matter of particular importance for Iltis. Introducing the first published volume (Vol.2 in the planned series), he presented "plant-portraits and views of associations taken in the region of Engler's Province of the European 'Mittelgebirge'. They are without exception original photo-prints from nature, untouched-up or altered."[68] As far as Iltis was concerned, the presentation of original photographs was a guarantee of authentic, objective representation. The accompanying volume of fifty pages included a brief introduction, summary accounts of the region's geology and climate, and an extended botanical account of the region from the floristic perspective of Engler's middle-European Province. Brief outlines followed for each of the vegetation types (Iltis used the term 'formation') depicted in the accompanying photographs. The volume closed with an index of species and a map showing the phytogeographic zones of the region.

Individual photographs provided 'views' of particular types of vegetation, whilst surrounding text identified the vegetation 'formation' in English, German and French, together with details of the location and altitude where the photo was taken, the name of the photographer, and the date. Below the image, Iltis listed characteristic species for the vegetation type, with names in bold for key species of interest featured in the photograph. Aside from a few such general views, however, the bulk of the photographs described individual species of botanical interest, whether for their relative rarity or simply as attractive species, isolated from their context in surrounding vegetation. The resulting images were plant portraits, not records of plant communities. In the absence of more general views depicting the vegetation from which such species were drawn, these photographs could only offer limited understanding of plant associations. Iltis's express intention in *Flora Photographica,* he said, was to describe not the traditional flora of a region, but "the vegetation-cover of the earth in its typical associations."[69] Yet most of his 'formations' were

[67] Iltis's Volume 2, covering parts of central Europe was published in 1928. Volume 1, written by Iltis's fellow Czech Karel Domin, was published in 1929 and covered and the West Indies. Iltis and Schulz 1928; Domin 1929; Dunn 1953.
[68] Iltis and Schulz 1928: 9.
[69] Ibid.: 5.



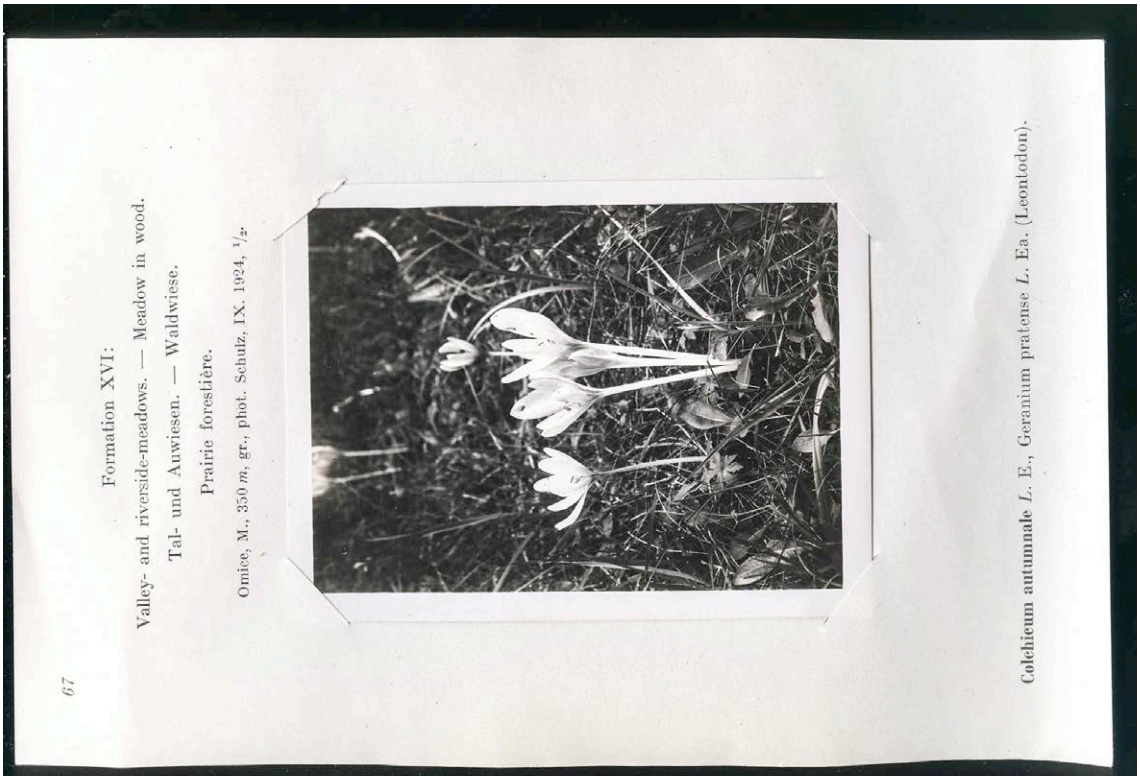


Fig. 4.19. Hugo Iltis-Bert Schulz. *Formation I: Pinus sylvestris, 1927.* From Iltis and Schulz 1928.

Fig.4.20. Bert Schulz. *Formation XVI: Colchicum autumnale, 1924.* From Iltis and Schulz 1928.

described in this way, highlighting species for their aesthetic appeal or floristic interest, with relatively little photographic evidence of the physiognomy or more general species-composition of the vegetation.

Iltis's combination of 'formation' views and plant portraits recollect those of Edward Salisbury who similarly collected general photographic descriptions of vegetation as well as studies of individual plants. Where Salisbury's images were likely to be contextualised by the systematic description of recognisable plant associations, however, Iltis's views and portraits were presented without the relevant phytosociological context. Doubtless, this lack could be remedied to some extent in the lecture-theatre, where he expected his images to be most useful but, here in published form, Iltis's accompanying text gave much greater prominence to floristic accounting than to vegetation description. The primary audience for *Flora Photographica* was a community of loosely affiliated, independent scholars - professionals and amateurs - from disparate backgrounds. Some would have been comfortable with the vegetation science of plant ecology; many were still dedicated to floristic plant geography. Iltis sought in his text to balance this disciplinary tension, reflecting back to different 'schools' of botanical science a 'picture' of vegetation and floristic botany that they could recognise. But the photography was misaligned with his declared purpose and suggested an ambivalence with respect to the plant community as an object of study. The result was to perpetuate the epistemological and disciplinary uncertainty that characterised both *Vegetationsbilder* and Engler and Drude's *Die Vegetation der Erde.* Even as *Flora Photographica* purported to foreground plant communities, it betrayed the provisional and unstable nature of vegetation as an object of study.

Picturing British vegetation

The uncertain status of vegetation in all these projects is especially evident when Iltis's pictorial strategy is placed alongside that of Arthur Tansley, in the latter's final great work on *The British Islands and their Vegetation.*[70] Published in 1939, Tansley's book was in many ways a much expanded and updated revision of the *Types of British Vegetation* of nearly thirty years earlier. Unlike the earlier work, however, to which several of his colleagues had contributed, Tansley was the sole author for this new, comprehensive monograph on British plant communities. The new work brought together the all the new vegetation studies undertaken by British ecologists during the intervening decades. Much of it had been published

[70] Tansley 1939.

elsewhere, especially in the *Journal of Ecology,* but here Tansley integrated those studies into a comprehensive, classificatory framework for British vegetation as a whole. W.H. Pearsall, whose own work on the vegetation of lakes was incorporated into the final volume, in a review for the *Journal of Ecology* branded the book "an ecological event of the first magnitude". Its descriptions of plant associations, formations and ecological relations, he said, demonstrated "a breadth, a unity and detail which had been lacking in the older work."[71] Tansley also used the book as an opportunity to confirming ecology's methodological foundations and to give a more integrated statement of "the valid essentials of a modern theory of vegetation."[72] In fact it went further even than this, by aligning all British vegetation work to date with the concept of the *ecosystem,* a term he had proposed in 1935 to indicate the interrelated complex of organisms and environment that constituted a unit of vegetation.[73]

The published volume ran to a nearly a thousand pages and incorporated no fewer than 418 photographs and 179 text figures, encompassing the full range of graphical forms and illustrations deployed in ecological literature over the preceding forty years. In this respect, Tansley's new book served to consolidate the visual argument of ecological study and affirmed photography's central rhetorical function for ecology. It is no surprise, therefore, to find that many of the illustrations from *Types* reappeared in the new book, along with numerous photographs supplied by others from their published papers in the *Journal of Ecology.* The most significant contribution to the book's photographic collection came, however, from Tansley's son-in-law, Richard Lythgoe (Fig. 4.21). A physiologist by training and profession, Lythgoe was a specialist in the physiology of vision and also a keen photographer. In the early 1930s, Tansley re-affirmed his belief in the importance of suitable photographic records for ecology, by enlisting Lythgoe's help to provide new photographs for the book. Throughout the 1930s, the pair toured the British Isles, Tansley directing Lythgoe in pursuit of new images to replace older examples, or to fill gaps in the photographic record for British vegetation. Seventy-nine of the resulting pictures were used in the book, 59 of which survive as original prints, along with a further 90 examples, in the Tansley Photographic Collection, now held by the BES. Lythgoe's photographs are conspicuous in the book for their technical competence and aesthetic consideration in comparison to most ecologist-photographers.

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71 Pearsall 1940b.
72 Tansley 1939: vi.
73 Tansley 1935.

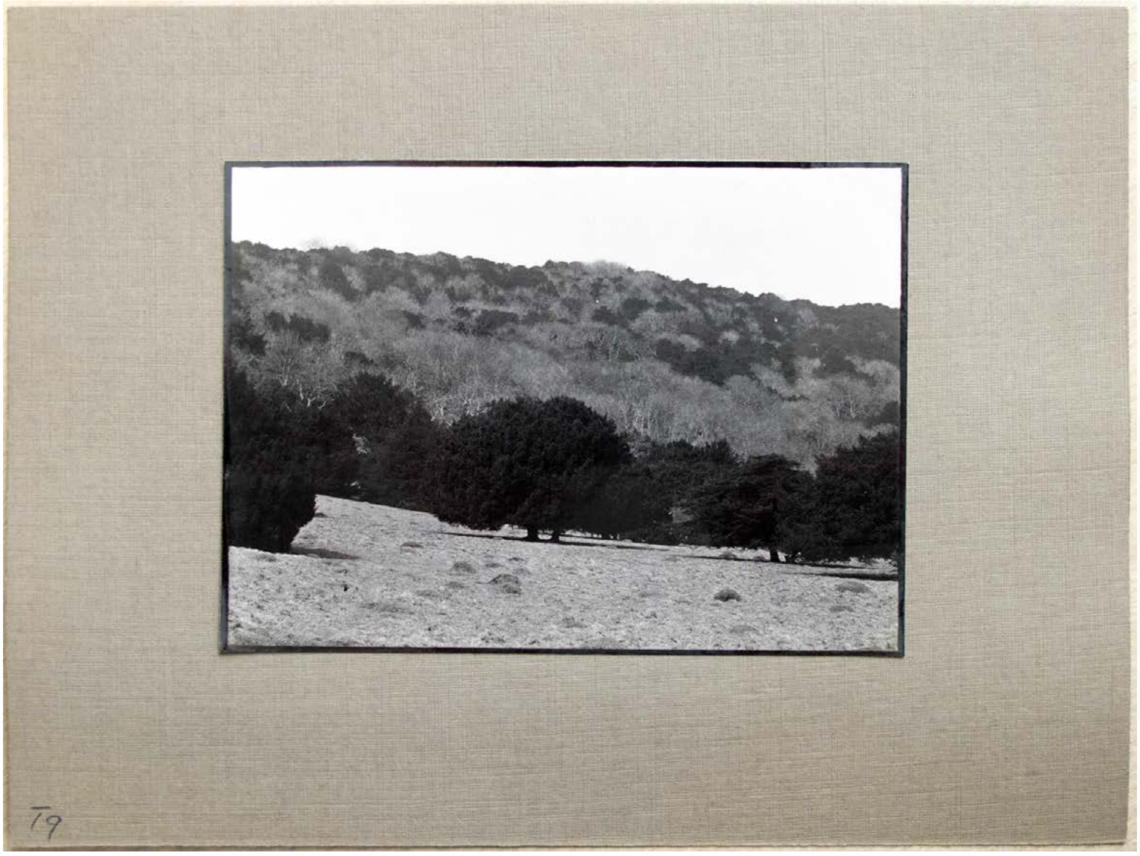

Fig. 4.21. R. Lythgoe. *Kingley Vale, Sussex, c.1935.* BES Tansley Photographic Collection. LYT/4/8.

Lythgoe's aesthetic sensibility aside, like Iltis's *Flora Photographica*, the photographs in Tansley's book are 'original', 'untouched-up', and 'from nature'. Tansley shared Iltis's confidence in photography's indexicality, its objectivity and its transparency. The photograph's transparency served to provide, 'at a glance', the character and species composition of typical vegetation associations, drawn from real examples. The 'objectivity' of the photograph ensured that a specific stand of vegetation could be referenced, one that has been recognised and witnessed by the scientific botanist-photographer. Unlike Iltis's images, however, Tansley's were never plant portraits of individual species of interest in their own right. Whether from *Types,* in journal papers or from *The British Islands and their Vegetation,* in Tansley's ecological photographs individual species were subsumed always into higher order units of vegetation. They were always contextualised by other photographs, maps, species-data and physiognomic description for the plant communities from which they took their meaning in a study of vegetation. The principle is neatly encapsulated in Plate 51, in which details of the field-layer vegetation are placed in the context of the Beech woodland community as a whole (Fig.4.22 overleaf).

PLATE 51

Phot. 114. *Fagus sylvatica* dominant but sparse (recently thinned). Seedlings and saplings of *Crataegus*, *Ilex*, etc. forming a low shrub or upper field layer. Buckholt Wood, Inferior Oolite. *C. G. P. Laidlaw.*

Phot. 115. *Daphne laureola* in Buckholt Wood. *Uehlinger.*

Phot. 116. *Neottia nidus avis*, *Hieracium serratifrons*, *Sorbus aria*. Buckholt Wood. *C. G. P. Laidlaw.*

Phot. 117. *Pyrola minor*, *Hieracium serratifrons*, etc. in deep humus. Pope's Wood, Cranham, Glos, on Inferior Oolite. *C. G. P. Laidlaw.*

COTSWOLD BEECHWOODS

Fig. 4.22. *Cotswold Beechwoods.* From Tansley 1939.

The British Islands and their Vegetation was the culminating statement of British vegetation study for its first half-century, and of a distinctive British perspective on vegetation science. The British view championed by Tansley had always stressed the importance of habitat factors in the recognition of vegetation types, because such an approach kept always in view the genetic and developmental processes that gave rise to distinct plant associations, and the environmental relationships between different communities. By the time the book was published, vegetation study in Europe was already becoming dominated by a more strictly phytosociological approach — often referred to as the Zurich-Montpellier school — in which the floristic character of vegetation (its detailed species-composition and community structure, not its 'flora') was accorded greater emphasis. Nevertheless, though they maintained different approaches to its study, British and European ecologists retained a common conception of the plant association and its importance in the critical study of living plants and their environmental relations. This distinction was ecology's foundational challenge to botanical science and one which required naturalists literally to take a new view of vegetation. That view could only be achieved by the direct study of plants growing together in nature, as a complex, relational phenomenon. In other words, it required botanists to go back out into the field and look again. In the remaining two chapters of this thesis, I will turn to examine the methods and practices that ecologists adopted to help them see ecologically when they went back into the field, and the points of contact between these ecological practices and other life sciences of the field.

5. Hidden in plain sight: Visual knowledge and ecological method

Chart, map, and photograph are records indispensable to the systematic study of vegetation... and in all careful vegetational study their use is no longer optional but obligatory. [1]

Some years ago, when I worked as a practising field-ecologist, my three-year old daughter was keen to know exactly which 'field' I spent my days in when I went out to work. Her innocent query points to a conceptual ambiguity for ecologists and other fieldworkers, though it is one few of them reflect upon. Just what kind of place is *the field* and where is it located? What kind of knowledge is knowledge *from the field*? These are questions properly asked within the context of the spaces of scientific practice more broadly, and I have addressed some of this context in my Introduction. Thomas Gieryn suggests that "the construction of 'the field' as a truth-spot is a literary accomplishment won through skilful rhetoric"[2] and, as the previous chapters of this thesis show, ecologists were particularly energetic in presenting a rhetoric of the field and its articulation as a particular kind of space for scientific study. The field is not only a rhetorical device, however, conjured to justify the outdoor jaunts of natural scientists. It is constructed also by the technical and affective practices of those who work there. My interest in the final chapters of this thesis, therefore, is to explore the relationship between practice and the subjective experiences of working 'in the field', as a productive complex for the construction of scientific knowledge. As a key to unlock this complex, I explore the detailed methods, proposed and practiced, by early ecologists in their pursuit of field-based knowledge. What was proposed and what was practised were not always the same. Some practices, such as vegetation mapping and detailed botanical recording, were consciously theorised and codified in statements of method. Others — methods for assessing and noting the relative abundance of plants, for example — went more or less unremarked, yet became standard procedure for ecological studies of vegetation. Fieldwork for ecologists was and is a physical and sensory engagement with plants, animals and environment, but very early in its development, that engagement became highly instrumentalised. Naturalists had long made use of a wide range of tools for collecting and transporting specimens, and for their subsequent preservation, arrangement and display.[3] In ecologists' field practice, these crafts of collecting, as Jim Endersby has called them,[4] were supplemented with a range of new

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[1] Clements 1905: 183.
[2] Gieryn 2002: 118.
[3] Allen 1976: 126 *et seq;* Larsen 1995; Endersby 2008: 54 *et seq*.
[4] Endersby 2008: 54-55.

technologies for taking precise environmental measurements by which to characterise habitats, in which photography occupied a central place. Whilst they rarely theorised its use, ecologists deployed photography routinely, not only in the straightforward representation of place and vegetation, but in mixed regimes of instrumentation for counting and measuring the objects of direct visual study. In addition to photography, those regimes included notebooks and pencils, together with maps and a range of related sketching practices, but also topographical survey equipment, quadrats and transects, producing new cartographic forms for visualising the character and distribution of vegetation.

Robert Kohler characterised ecological photography, rather simplistically, as a surrogate form of note-taking — a time-saving device and more pleasurable than writing.[5] This was certainly one function for photography in ecological fieldwork, but photographic recording was also much more. As we will see in this chapter, the camera was expected to record what cannot be put into words when describing vegetation. The camera took its place in the larger regime of ecological field instrumentation, but it also stood apart from other instruments for counting and measuring. As an instrument of precision, it was a cipher for accuracy and objectivity but it also authenticated subjective visual experience and judgment, attesting both to the ecological object in place, and its scientific eye-witnessing by an ecological observer.[6] Together with other forms of instrumentation, ecological photography was an active practice of looking, as well as a technology for the direct transcription of visual evidence into representation. This chapter examines the photographic practices of field ecology in the context of this mixed regime of instrumentation, to reveal the embodied visual foundations for ecological science and experience. This approach is extended in my final chapter, to reconnect ecology with a broader culture of collecting and exchange in field natural history.

Scaling the view: Vegetation mapping and visual ecology

Some 25 years ago, Jane Camerini drew attention to a growing critical scholarship in the history and theory of cartography. She narrowed the focus of that scholarship to a consideration of the role of maps as visual representations put to work in the development of evolutionary biology. She was concerned to discover "how levels of map meaning participate

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[5] Kohler 2002a: 126.

[6] For a fascinating series of highly personalised accounts of the practice and implications of keeping field notes, see Canfield 2011.

in the development of particular sciences".[7] Her observations are equally apt transposed to other visual methods in science, and allow us to ask similar questions concerning levels of photographic meaning in science, and the role of photographic practices more specifically within ecology. They do so not only by suggesting a model for inquiring directly into photographic practice, but also by offering an indirect inquiry into photographic function and meaning, through a study of analogical visual practices. In the following discussion, therefore, I will take this indirect route through the survey and mapping practices of early ecologists, to suggest a visual parallel for understanding the role of photography in their developing science.

Discussing the problems of ecology at the BAAS in 1904, Arthur Tansley characterised survey work as the first essential 'descriptive stage' of vegetation ecology. Vegetation survey and mapping would reveal the topographic correspondences of physical and biological phenomena, and provide a foundation for more detailed studies of the functional and generative capacities of such correspondence. A topographical survey of vegetation was required, he suggested, to build a complete and direct 'mental picture' of vegetation.[8] This mental picture was the essential, intuitive outcome of scientific curiosity, and it demanded careful and comprehensive delineation, through exhaustive survey and appropriate visual representation. At the beginning of the 20th century, there was no more appropriate means for achieving this than through cartography. This commitment to a mental picture of vegetation, and its visual representation through mapping, lay at the heart of the British Vegetation Committee's (BVC) project for promoting ecology in its first decade. For ecologists, however, mapping also stood in a close relationship with photography. As field methods for recording vegetation 'first-hand', both offered technologies for the direct transcription of field observations. Both were seen as providing permanent records of value in communicating to others the findings of ecological vegetation survey; and both offered epistemological confirmation for plant associations as natural objects, and for their visual and spatial relationships.

From one perspective, vegetation maps like those of the Smith brothers in Scotland and Yorkshire were manifestations of a broader, late 19th century cartographic impulse, to chart

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[7] Camerini 1993b: 704. Other relevant studies of the use of maps in science include Arthur H. Robinson, *Early Thematic Mapping in the History of Cartography* (Robinson 1982), Janet Browne, *The Secular Ark: Studies in the History of Biogeography* (Browne 1983), and Jane Camerini, 'The Physical Atlas of Heinrich Berghaus: Distribution Maps as Scientific Knowledge', (Camerini 1993a).

[8] Tansley 1904a.

the geographical distribution of every natural phenomenon imaginable[9]. A number of notable *botanical* maps had appeared at intervals through the 19th century. Humboldt's 1805 *Tableau physique* from Mt. Chimborazo (see chapter 2, Fig. 2.1), although not presented as a planar projection, was among the first such 'maps'.[10] The tradition of botanical cartography was refined through the latter half of the 19th century, especially by German botanists August Grisebach and Oscar Drude, who both provided maps for the publishers of the celebrated Berghuas *Physikalischer Atlas*. Section 5 of the 1887 edition of that *Atlas*, which dealt with plant geography, was edited by Drude and may be regarded as the epitome of botanical cartography of the period (Fig. 5.1).[11]

Jane Camerini has shown the importance of these distribution maps as "tools of biogeographical thought", and emphasised their role in bringing order to large and complex biological datasets.[12] This was certainly the driving conception behind Drude's cartographic phytogeography and remained part of the motivation for mapping amongst early ecologists, who were themselves trained as botanists. Drude's atlas maps were the product of painstaking research to bring together botanical records from local floras, travel accounts,

[9] After around 1850, such maps were commonly incorporated into published atlases of physical geography, treating everything from the topography of the world's mountains and river systems, to astronomical mapping, including maps of geology, oceanic and atmospheric currents, the earth's magnetism, zoology, botany, political territories and ethnography. These cartographic innovations emerged most clearly in Germany, with the publication of single maps and then atlases by Heinrich Berghaus whose *Physikalischer Atlas* was first published in two volumes in 1845 and 1848, and was intended as an illustrative companion to Alexander von Humboldt's *Cosmos* (Rupke 2001: 1). The best known examples in English followed the Berghaus model and included Alexander Johnston's *Physical Atlas of Natural Phenomena* (Johnston 1850); Augustus Petermann's *Atlas of Physical Geography* (with texts by Thomas Milner) (Petermann and Milner 1850); and Thomas Milner's own *Descriptive Atlas of Astronomy, and of Physical and Political Geography* (Milner 1850). Johnston's *Atlas* was extensively used by Charles Darwin and also had a place in Alfred Russel Wallace's library (Camerini 1993b). The Berghaus Atlas and its plant and animal maps are discussed by Jane R. Camerini in "The Physical Atlas of Heinrich Berghaus: Distribution Maps as Scientific Knowledge," (Camerini 1993a).

[10] Humboldt and Bonpland 1805 [2009]. At around the same time, Augustin de Candolle defined and mapped floristic regions for France and, in 1823, Danish botanist Joachim F. Schouw produced an atlas describing the global distributions of a range of major plant groups, to accompany his *Outline of a general plant geography*, published the previous year (Lamarck and Candolle 1815; Schouw 1823). These maps established a tradition of thematic plant cartography that continues to the present day. In 2015, the University of California, Berkeley listed no fewer than 943 such maps across the globe, in a checklist of *Online Vegetation and Plant Distribution Maps* (http://guides.lib.berkeley.edu/VegMaps [Accessed 09 Sep. 2015]), which includes only maps which have been made available online.

[11] Drude, Oscar. 1887. *Atlas der Pflanzenverbreitung.* Hermann Berghaus (ed.), *Physikalischer Atlas*, section 5. The atlas was produced by Justus Perthes publishing house in Gotha, Germany. Grisebach's map, which accompanied his own *Die Vegetation der Erde* (Grisebach 1872), was published by Perthes as a single sheet in 1866. From around 1876, Drude succeeded Grisebach as effective consultant on plant geography to the publishing house. (Güttler 2011: 10)

[12] Camerini 1993b: 709.

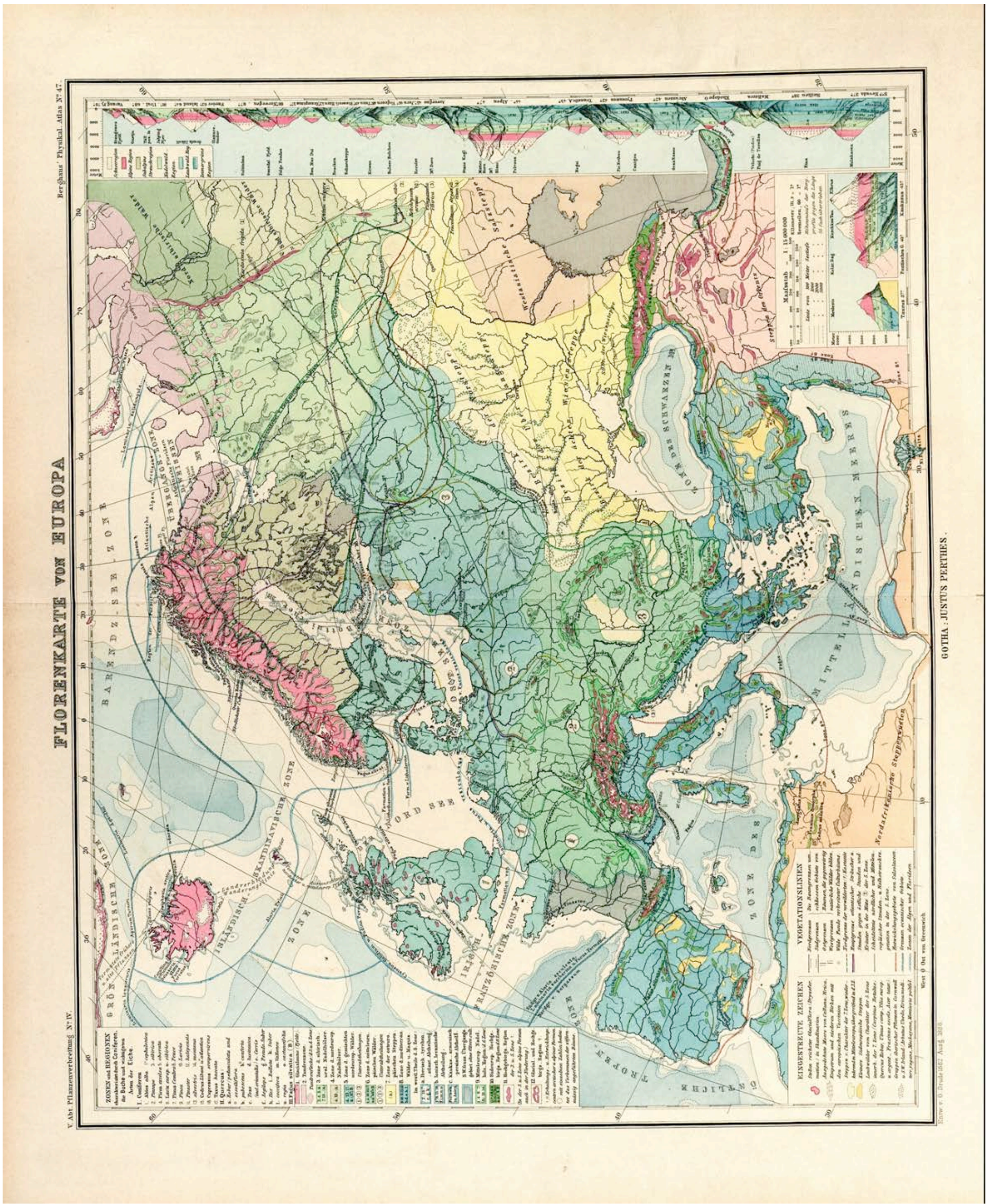

Fig. 5.1. Oscar Drude 'Florenkarte von Europa', 1887, from the "Atlas der Pflantzenverbreitung", in *Berghaus' Physikalischer Atlas*, Section 5, Plate No. IV.

botanical monographs and herbaria, and oral accounts from other botanically-minded travellers. Only a limited amount of data were drawn from Drude's own fieldwork.[13] The purpose of the maps was to draw together these disparate data sources, which could not be obtained through the efforts of any single worker, to provide a broad, thematic framework for the interpretation of botanical information. Drude used them extensively for teaching, both as a University professor and as a prominent and active member of his local natural history society in Dresden, encouraging other botanists to use them as a means of standardising observations.

Nils Güttler has suggested that, in developing continental maps depicting both floristic 'realms' and vegetation 'zones' together (Fig. 5.1), Drude achieved the re-integration of floristic and vegetational data, whose separation had so troubled Humboldt, Kerner and other early vegetation workers. Drude himself was surprised and delighted by the apparent congruence of the two datasets, which became manifest only upon seeing his completed map.[14] Despite their visual agreement on paper, however, the floral zones and vegetation lines of Drude's atlas maps were not visible entities. They presented a top-down cartography, based upon generalised data, and the imposition of abstract botanical categories, within an idealised cartographic space. Such categories could not be directly referred to the real topography or vegetation of the mapped landscape. A direct 'mental picture' of vegetation, as envisaged by Tansley in 1904, could not be achieved by this kind of synthetic treatment of other kinds of data. True vegetation survey and mapping required "extensive comparative work in the field...[to] work out the distribution of vegetation systematically".[15] Drude too was aware of the difference between synoptic mapping along phytogeographic lines and a topographic survey of actual vegetation. From the late 1890s, as Güttler points out, his approach to phytogeographical cartography became increasingly ecological. At the heart of the shift, as Güttler says, was a question about the scale of maps; but the question of scale was especially significant in this context because it also had a bearing on the character of scientific observation. The transition to ecological mapping was a move away from abstract categories, towards empirical data and direct, first-hand observation. Mapping in early botanical ecology was not about shaping disparate ecological datasets. Ecological data *per se*

[13] Güttler 2011: 16

[14] Ibid. In fact, the coincidence of Drude's floristic realms and vegetation zones should not have been so surprising. Both were, after all, syntheses based on overlapping datasets, drawing on the same floristic data and vegetation accounts. This point aside, Güttler's paper provides a valuable account of Drude's relationship with botanical maps and with the Perthes publishing house.

[15] Tansley 1904a: 197.

were only just becoming recognisable at the end of the 19th century and were in any case much too sparse to warrant synthetic treatments like those of the Berghaus atlases. Rather, ecological vegetation maps were the expression of a desire to describe and define distributions for a new kind of biogeographical knowledge. They depicted the character and geographical relations of particular plant associations, determined not through the synthesis of heterogeneous botanical observations, but by systematic, first-hand recording in the field. This *required* a shift in the scale of mapping, to that of human vision; only what could be seen could be mapped.

Scale mattered to ecological vegetation surveyors. Maps at too small a scale risked over-simplification, since broad vegetation categories only could be depicted, whereas the aim of this new kind of vegetation mapping was to chart the local distinctiveness of different *kinds* of vegetation. It was essential, therefore, to work in the field with maps of a sufficiently large scale to depict discrete plant associations and the boundaries between them. A preference for larger scale maps was expressed by all British ecologists active in this kind of work, but their facility in vegetation survey received its fullest expression from Oscar Drude. Drude suggested that large-scale maps (1:25,000) were too extensive for most print purposes, for which smaller-scale maps were preferable, providing an overview of the distribution of broad vegetation types (formations). He made it clear, however, that larger scale maps were necessary for a detailed understanding of the particular 'expression' or character of vegetation formations as they occurred in the landscape, or for the location of important species, especially those which were most characteristic of the plant communities present. Reporting on vegetation surveys of Saxony in 1900, and again in 1908, Drude provided maps at a scale of 1:25,000 (c.2 ½" per mile), at which resolution the details of field boundaries and other features were preserved. He emphasised the value of such large-scale mapping as essential for a proper understanding of the relationships between soils, related habitat factors and vegetation.[16] His map legend distinguished thirty-seven separate types of vegetation, with further subsidiary associations in the text. This compares with less than twenty mapped

[16] Drude 1900: 27; Drude 1908: 11-12. Drude also referred to the recent Yorkshire work of William Smith and others when discussing his own vegetation maps. As one might expect, Drude was well aware of the vegetation work underway elsewhere, including Britain, France and North America; this is clear also from his earlier paper on the Saxony survey, presented to the Vienna International Botanical Congress in 1905. His accounts of the Saxony survey do not acknowledge any direct methodological influences, but the methods and outputs both suggest a development of the work begun in France by Charles Flahault in the 1890s and developed by the Smith brothers for a British context (Drude 1906b: 427; Drude 1908: 14).

associations in the most detailed equivalent British surveys at this time. Even allowing for the possibility that the Saxon landscape was ecologically more diverse than the Scottish lowlands or parts of Yorkshire, these numbers revealed the substantial enhancement in resolution and accuracy achievable with the use of larger-scale maps (Fig. 5.2 overleaf).[17]

Such large-scale maps, coloured to depict vegetation, were costly to reproduce, however, and no British examples were published at this scale. The first *published* vegetation maps in Britain, prepared by the Smith brothers and other members of the BVC, were of a relatively small scale — most commonly 1″ to 1 mile (1:63,360), but sometimes smaller still. In the first surveys, in Scotland and Yorkshire, the Smith brothers mostly used 1″ maps for sketching in the field, reducing the published map to 2″ to one mile (see chapter 2, Fig. 2.8). For single-handed surveys of such extensive regions, it is perhaps unsurprising that Robert Smith settled on a comparatively small-scale map, especially for field survey purposes.[18] But, like Drude's overviews of vegetation, these were considered preliminary surveys, intended for the "primary analysis of vegetation", not its detailed description.[19] There is no doubt that the survey was compromised by this scale of mapping which, when reduced still further for publication, rendered a much simplified and less legible picture of vegetation types and their distribution. "It is obvious," wrote Charles Moss, "that every plant community cannot be indicated on a map of this scale (1:63,360); and hence the plant geographer has frequently to subordinate minor units of vegetation to units of wider significance."[20]

The Smiths, and their fellow vegetation ecologists, were well aware of the compromise they were making, and 6″ (1:10,560) Ordnance Survey maps were soon adopted as standard for use in the field, even when publication was restricted by cost and convenience to 1″ maps.[21] These larger-scale maps represented the results of direct, empirical research, obtained through field survey and deployed to describe the character of particular, visually discernible plots of vegetation, recognised and mapped *in situ,* at the time of survey. Only through such topographical surveys, Drude insisted, could the concepts of vegetation

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[17] The most detailed British maps were produced from Irish vegetation surveys, by George Pethybridge and Robert Lloyd Praeger. (Pethybridge and Praeger 1905)

[18] Smith 1900a Smith 1900, Smith and Moss 1903 1903b; Lewis 1904 Lewis 1904; Moss 1907, Moss 1913. As any field surveyor knows, the use of large scale maps in the field will disproportionately increase the time required for mapping. This was certainly the case for these early vegetation surveyors. George Pethybridge and Robert Praeger (Pethybridge and Praeger 1905: 139) observed as much in reporting their Irish surveys. See chapter 3 of this thesis for an account of the continuing efforts of British ecologists to promote vegetation survey and mapping.

[19] Smith 1902Smith 1902: 138; Smith and Moss 1903: 378; Smith 1904: 620

[20] Moss 1913: 18.

[21] Smith 1905a.

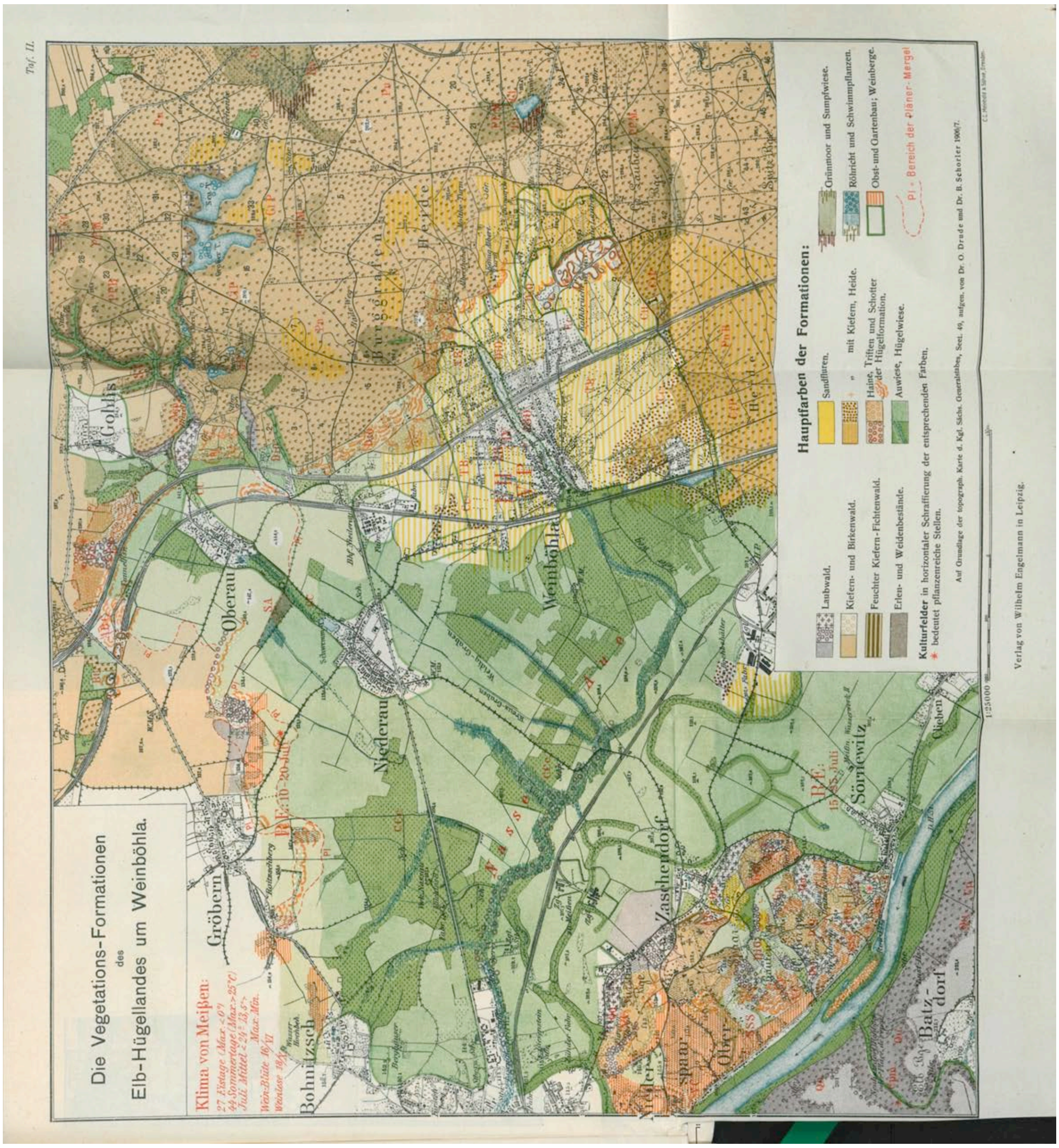
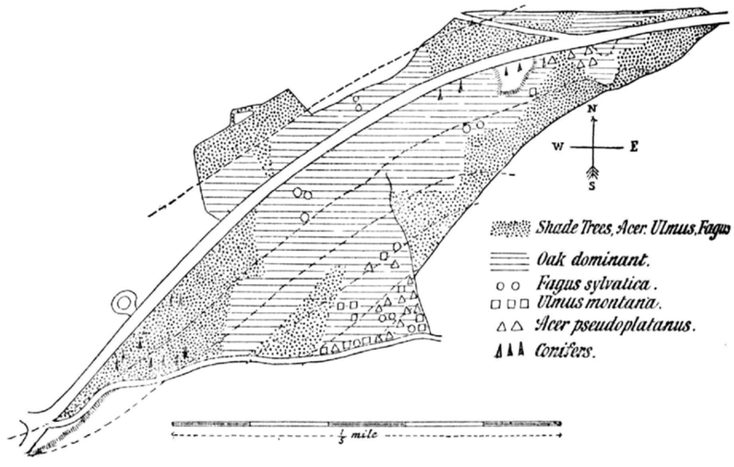


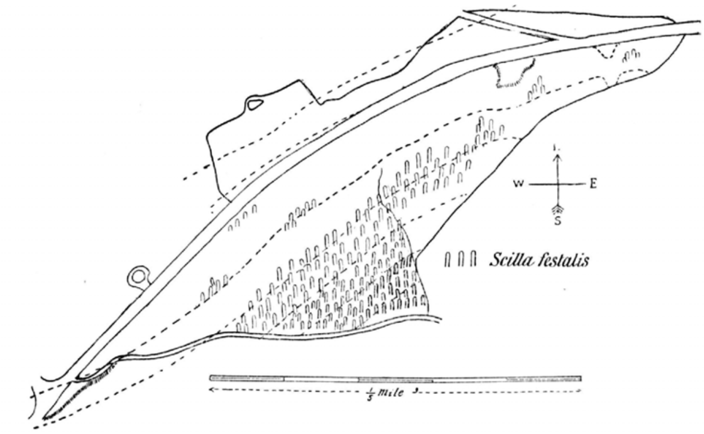
Fig. 5.2. Oscar Drude, *Die Vegetations-Formationen des Elb-Hügellandes um Weinböhla*, from Drude 1908, "Die kartographische Darstellung mitteldeutscher Vegetationsformationen", in *Bericht über die Zusammenkunft der Freien Vereinigung der Systematischen Botaniker und Pflanzengeographen.* Leipzig, 1903-1909. Vol. 5 (1908) pp.10-38.

Fig. 1.



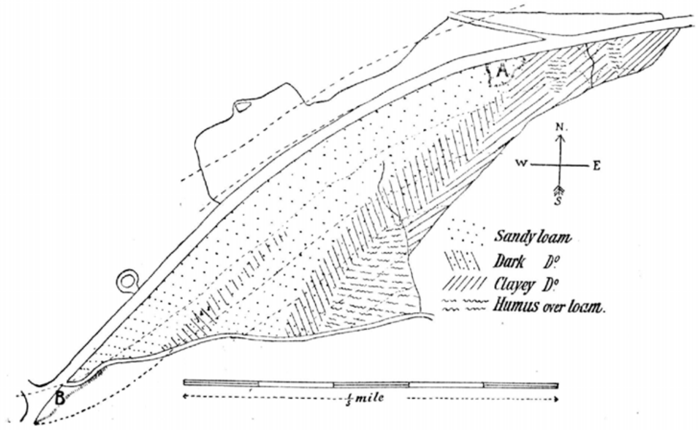
BIRKS WOOD.
Map showing the distribution of Trees.

Fig. 3.



BIRKS WOOD.
Map showing the distribution of *Scilla festalis*.

Fig. 4.



BIRKS WOOD.—Soil Map.

Fig. 5.3. T.W. Woodhead. *Vegetation and soil maps,* drawn onto photographically reproduced tracings from 25" Ordnance Survey. From Woodhead 1906.

formations and their sub-divisions be made clear. "Only cartographic recording of a particular landscape can do justice to all the questions which may arise;" he wrote, "the map forces the botanist to make final decisions on the spot."[22] Large-scale maps were a pre-requisite for the visual representation of vegetation distribution and made Arthur Tansley's aspiration to a "complete mental picture of vegetation" a realistic objective for the work of the BVC.[23]

The shift to larger scale maps also reflected a broader trend in British ecology which, in its first decade, became increasingly directed towards more detailed, localised studies of vegetation.[24] When Thomas Woodhead came to survey the plant associations of his local woodlands in 1903, he took advantage of both the 6-inch and the very detailed 25-inch ordnance survey maps then available for the area surrounding Huddersfield in the West Riding of Yorkshire. In this work, Woodhead sought to establish correlations between vegetation cover and a range of ecological parameters, including temperature, altitude, shading and soil conditions (Fig. 5.3).[25] In writing up the work, he gave precise details for his methods for soil survey, entailing a sampling-grid at 10-yard intervals, plotting the results onto a gridded large-scale map. He referred in his account of the work to other studies by Frank Oliver and Arthur Tansley, which also included also "a method of surveying vegetation by means of squares".[26] For comparison, he overlaid the results of vegetation surveys and soil sampling onto the same large-scale base maps. He was less explicit on the method of vegetation mapping but the mapping was clearly undertaken by eye, sketching directly onto his base-maps, in the field.

This kind of visual understanding was further accented by an ecologist's habitual use of photography. Woodhead's 1906 paper (his published PhD thesis), unusually, included no photographic illustration. However, an earlier paper, appearing in *The Naturalist* and covering some of the same work, did include photographs (Fig. 5.4) and, from the account of the mapping process in both papers, the visual character of the survey is manifest. Both papers were also abundantly illustrated with other kinds of graphic visualisations, including sketch-

[22] Drude 1906: 432; Drude 1908: 11.
[23] Tansley 1904a.
[24] Kaat Schulte-Fischedick (1995, 2000) charts this shift in emphasis in British ecology. In fact, the desire for a national, broad-scale vegetation survey remained very strong in British ecology, throughout the 20th century. At the same time, more detailed studies were also considered essential, to understand the local basis for variation and change in vegetation.
[25] Woodhead 1904, 1906.
[26] Woodhead 1906: 341. Oliver and Tansley's *Experiments in ecological surveying* are considered later in this chapter. However, the fieldwork for Woodhead's study preceded the work by his colleagues, or the establishment of the BVC.

maps, photo-micrographs and drawings from photo-micrographs, as well as innovative cross-sectional drawings of soil profiles and plant root-zones.[27]

Fig. 8.—Bluebells in a Sycamore-Elm-Beech Wood.

Fig. 5.4. J. Bruce. *Bluebells in Birks Wood, near Huddersfield, West Yorkshire.* From Woodhead 1904.

When writing up their vegetation surveys, ecologists like Woodhead and Drude deployed a mix of verbal description, scientific observation (species data) and visual artefacts (photographs, maps), as evidence for the plant associations recognised in the field. Vegetation survey required detailed cartographic recording, to register accurately the character and distribution of plant communities across a particular landscape. As Drude said, the map forced a surveyor to make judgements on the basis of direct visual experience, 'on the spot.'[28] In vegetation survey, the photograph forced its own association with map and

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[27] The later paper (ibid.), published in the Journal of the Linnean Society, was prepared originally for submission as a PhD dissertation to the University of Zurich. It is possible that the lack of photographic illustrations in the 1906 paper reflects constraints for publishing in this context.

[28] Like the related phrase 'from nature', which was widely applied to pictorial illustrations throughout the Victorian and Edwardian periods, including drawings, paintings, engravings and photographs, 'on the spot' was a shorthand for veracity and scientific accuracy, obtained by first-hand witness and the faithful transcription of direct observation. The phrase was used repeatedly by early vegetation ecologists including, Oscar Drude (Drude 1908: 11); and William Smith (Smith 1902: 137) as well as field-workers in other disciplines. Other examples from geographical botany and natural history include Hooker and Thomson 1855: 74; Hey 1891:215; Fitch 1891: 251; Elwes and Henry 1906: xv; Grinnell 1912: 104. For instances of the phrase in anthropology and in photographic surveys see

species data, through the representation of a particular physiognomy, clearly located and directly experienced within an identifiable geographical space. The reification of plant associations was assured by their depiction in photographs, and by their registration to particular places on a map. Photographs and map together, used in this way, were more than merely illustrative. They provided evidence of vegetation communities as epistemic objects, attesting to their appearance in the eye and experience of the ecological surveyor.[29]

Mapping, rational inventory and affective knowledge

The importance of the Ordnance Survey in facilitating organised, extensive vegetation survey, and field studies of all kinds in Britain cannot be over-stated. Large-scale, topographically detailed maps, covering all parts of Britain, were made widely available by the Ordnance Survey from the 1880s onwards.[30] References to the use of OS maps litter the pages of natural history journals from the last decades of the 19th century and into the 20th, and OS maps were routinely used by local naturalists in their rambles and collecting excursions, and for surveys of all kinds.[31] OS maps also featured frequently at BAAS meetings, in use for every kind of survey, and were so integral to the conduct of science that the 1890 General Committee of the BAAS recommended its Council should "urge upon Government to take steps to hasten the completion of the Ordnance Survey and to afford the public greater facilities for the purchase of the Survey Maps."[32]

Nor was the development of state-sponsored cartographies, and their popular dissemination in large-scale maps, solely a British phenomenon. Oscar Drude's vegetation mapping practices were equally premised on the availability of new large-scale maps commissioned by the state of Saxony.[33] Similarly, ambitions for a vegetation map for the whole of France, proposed by Charles Flahault in 1894, relied upon appropriate large-scale maps, supplied by the French Army Geographical Service (Service Géographique de

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Edwards 2001: 38, 167; Edwards 2012a: 196; and amongst antiquarians and archaeologists, Kenworthy 1891: 99; Maudslay 1902 : 30; Naylor 2003: 314.

[29] The notion of 'epistemic objects' provides a useful tool for thinking about objects of scientific inquiry, especially those objects which appear to have some alternative, common sense reality as natural objects. The notion problematises what we think we know about such objects and forces us to rethink their status as fundamental entities or structuring principles of knowledge, both scientific and general. The concept and term have been given currency by the philosopher of science Karin Knorr Cetina (1981, 1999, 2001).

[30] Seymour and Andrews 1980: 178-9.

[31] See, for example, in the pages of *The Naturalist* (Harker 1905, Johns 1905, Smith 1906).

[32] BAAS 1891: lxxxvii.

[33] Güttler 2011: 26-7.

L'Armée).[34] This cartographic visualisation made it possible for Victorian and Edwardian naturalists and geographers to conceive of and aspire to a total knowledge of the distribution of a range of natural phenomena, across national landscapes or whole continents. This in turn has encouraged theorists of cartography to characterise the map as a technology of regulation. Most commonly, however, the value of these newly available large-scale maps was realised at a local level, by enthusiasts engaged in geographically related study and exploratory leisure.[35] The capacity of maps for re-appropriation to alternative and resistant modes of thought and practice is often evident even when their regulatory power is most apparent.[36] Angèle Smith has illustrated this kind of repurposing or re-inscription for maps, in

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[34] Flahault 1894.

[35] It is clear from the accounts of field scientists and amateur naturalists, that a strong sense of locality, and an attachment or devotion to their own places of excursion and study, was central to natural history field practice. A similar localism was active among other fieldworkers, including geologists, antiquarians, meteorologists and survey photographers, all of whom would have made extensive use of the same large-scale OS maps. The currency of Ordnance Survey in all these contexts was such that its topographic survey and print technologies can be regarded as critical for the emergence of localism in natural history and other sciences in the late 19th and early 20th centuries. For a comprehensively drawn example of this kind of localism in field sciences, see Naylor 2010. Edwards (2012a, 2014b) especially draws attention both to a strong sense of localism and the importance of OS maps in the conduct of regional photographic surveys in Britain from the 1880s to the 1920s. Bowler (1992), Allen (2003) and Benson (2009) all assert the importance of the Ordnance Survey for the British geological survey. Simultaneously, OS maps became staples of outdoor leisure activity, from mountaineering (Lorimer and Lund 2003) to rambling and cycling; and, ultimately, a central support for 20th century national and local land use survey and planning (Sheail 1995; Cosgrove 2008: 28-29).

[36] In an influential essay written in 1989, the geographer J.B. Harley pointed out that the map is a kind of inventory or catalogue and that "To catalog the world is to appropriate it" (Harley 1989 [2001]: 166). Following Harley, many others have observed the rational and universalising tropes associated with cartographic representation and mapped knowledge in all its forms, and their regulatory functions. For examples, see Harley 1988; Wood and Fels 1992; Frake 1996; Smith 2003; Pickles 2004; Wood *et al* 2010; Edwards 2012a. The origins of such maps, in military surveys for the purposes of political control and taxation, has led to the historical theorisation of cartography in general, in Foucauldian terms, as an inherently regulatory technology. Maps are instruments of power, a hegemonic tool of social, political and epistemological regulation. Bruno Latour (1990) has characterised such a map as an *immutable mobile*, an attempt to fix representation of the structured world for particular purposes, particular interests; rendering stable meanings that are infinitely transferable to new contexts of communication. It is clear, however, that maps also facilitate their own subversion, through appropriation to other social or disciplinary purposes. Whilst acknowledging the implicate relations of maps, knowledge and power, some scholars also recognise a counter-hegemonic force in the practices of map use (Smith 1998; Smith 2003; Pickles 2004; Edwards 2012a). The novelty and variety of interests entrained in such contexts of use dissolves the 'immutability' of the translated mobile. Far from being immutable mobiles, maps (and photographs) may be transformed, materially and semantically, and actively appropriated to alternative discourses. They may be transcribed or reproduced in new forms, or in new presentational contexts. They may be subject to superscription (literally, writing on or overdrawing), translation or re-interpretation in terms of other interests than those for which the original was made. This kind of appropriation and re-inscription reveals a mutability of structured meaning in representation, and the capacity of

what she calls a 'strategy of inversion', by which the colonial maps of the Ordnance Survey in Ireland were appropriated as potent symbols by Irish Nationalist parties in the late 19th century. An instrument of regulation and control was thereby subverted to a tool of resistance.[37] This kind of re-inscription has led John Pickles to suggest that cartography should be 'de-ontologized', that we should pay less attention to the Cartesian representational work of maps and mapping and consider their capacity for resistant practices of 'counter-mapping' and a 'cartography of experience'. In other words, that we should seek a practical perspective, to ask not what maps are or what they represent but what work is performed through mapping.[38]

For field science, this practical opening of cartographic theory would need to take full account of the cognitive and aesthetic functions at play in the subjective experience of one actively engaged in mapping *in the field*. In this context, even as they are used to rationalize and discipline knowledge, maps may be understood also as vehicles for collecting and certifying experience. This has been convincingly demonstrated by Elizabeth Edwards, bringing mapping and photography together in a field-survey context. Edwardian survey photographers who aspired to scientifically regulated record, she says, but fell constantly prey to their own 'meandering subjectivity', overwhelmed by the aesthetic and embodied practice of photography in the field.[39] The experience of map use in the context of ecological vegetation survey shows that such imaginative overlay does not require the presence of photography. With Edwards' survey photographers, photography and cartography provided corroborative, rational technologies of inventory and evidential support for the material survivals of the past. In practice, both also became prosthetic technologies of affect, capable of recording not only material remains but the embodied experience of survey practice itself. Just so, for ecological vegetation surveyors using maps and cameras, subjective encounter

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representational objects — in speech, image and text — to facilitate their own re-use in novel contexts. For further consideration of the Latourian 'immutable mobile' in relation to mapping, see *Sketching knowledge* below.

[37] Smith 1998.

[38] Pickles 2004: 184-194. "To ask what a map is and what it means 'to map'," Pickles reminds us, "is also to ask about the epistemological and ontological structure of the world in which we live and map." (p.76). He suggests that we should "dislodge our commitments to solid and fixed identities, and instead... think about ways in which flows, relations of difference, and change can be mapped." (p.184). Collaborating with health-education researchers in a study of migrant farmworkers in North Carolina, geographer Altha Cravey has documented just such an active, experiential cartography. The farmworkers were asked to engage in a mapping exercise, which proved an effective "...means of affirming participants' unique experiential knowledge, and...knowledge of...their environment." (Cravey *et al* 2000).

[39] Edwards 2014b: 199-200, 203; Edwards 2012a: 67.

with the vegetated landscape, "ran both with and against the grain of maps."[40] The ecological survey practices described here are also examples of John Pickles' counter-mappings and confirm that a 'cartography of experience' is nothing new. Map use in the field, whether in map-making, or in navigation and orientation, is an active, embodied and spatially engaged process for transcribing experience and knowledge between perceptual world and cartographic image. Both map and camera *in use* are deployed to negotiate relations between private subjectivities and the world-out-there. For this reason, maps and photographs are also infinitely susceptible to appropriation and re-inscription. Almost they invite their own subversion through the super-positioning of new, often resistant representations.[41]

As in cartography, theoretical engagements with photography must be de-ontologized if they are to pay adequate attention to the active practices of *doing photography* and *using photographs*. Elizabeth Edwards has been important here too, consistently drawing attention to what she has called the 'infinite recodability' of photographs. As we saw in the case of Andreas Schimper's photographic illustrations in chapter 2 of this thesis, and in the photographic monographs on vegetation featured in chapter 4, such recodings are not always

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[40] Edwards 2012a: 67.

[41] Brian Harley's remarks regarding the map-as-inventory (see nn. 44 above) also suggest this link between mapping and photography. Harley's comment was adapted from an earlier observation by Roland Barthes ("The Plates of the encyclopedia" in Barthes 1980. The original essay was written in 1964.) Writing about the idea of the Encyclopedia, Barthes asserted that "inventory is never a neutral idea; to catalogue is not merely to ascertain, as it appears at first glance, but also to appropriate." Widely known as a literary theorist and philosopher of language, Barthes is also something of an emblem (almost a fetish) for photography theory. His remarks were echoed not only by Harley in relation to maps, but also by Susan Sontag (that other ideograph of photo-theory), who observed that "to collect photographs is to collect the world…To photograph is to appropriate the thing photographed. It means putting oneself into a certain relation to the world that feels like knowledge - and, therefore, like power." (Sontag 1977: 3-6. Sontag's essay, published in a 1977 collection of her writing *On Photography,* under the title "In Plato's Cave", was first published in 1973 in the *New York Review of Books.)* In this formulation photography, like cartography, presents us with rational vision, regulated knowledge and hegemonic power. But Sontag also acutely observed a dual ontology for photography. Even as it appears to appropriate the world, the knowledge-power of the photographer is also "a way of certifying experience." The photograph acquires not the world, but its phenomenal appearances in the eye of the photographer. Further theoretical connections between maps and photographs are discernible. Like photographs, maps have been variously characterized by a range of metaphors of realism, as if they present an unproblematic, even self-evident picture of the world. As Denis Wood says, "'Mirror,' 'window', 'objective', 'accurate', 'transparent', 'neutral': all conspire to disguise the map as a … reproduction … of the world, disabling us from recognizing it for a social construction which, with other social constructions, brings that world into being" (Wood and Fels 1992: 22). The parallel here with modernist photography theory and its post-modern critiques is striking. Both maps and photographs have been re-conceived as texts, discourses to be de-constructed to uncover structural meanings obscured by their realist representational surfaces. Both have been deconstructed, following Foucault, as instruments of power, articulations of what Foucault called 'regimes of truth'. (Foucault 1977: 109-133) For recent discussions of this theoretical history, see Gockel 2013: xi-xxxiii; Kelsey and Stimson 2008: ix-xxxi.

complete of successful. Nevertheless, photographs and maps share this capacity for re-inscription through practice, appropriation and re-contextualization.[42] In understanding the effects of such re-inscription, we should be sensitive to the possibility that our encounter with a photograph or map is itself a re-contextualisation. But we should also be conscious that a photograph's immediate context of production also differs from its subsequent (re)presentations. Even when presented by its original author, a photographic print is already a re-coding of experience to the forms of representation and already amounts to a re-inscription.[43] This should be borne in mind when considering the visual practices of field surveyors. The subsequent visual representations of survey — maps and photographs of vegetation, for example — are the products of intentional discourse. As the following examples will indicate, the use of maps and cameras in the field provided not only evidential supports for the objects of survey, but cognitive extensions for the visual, embodied experience of 'on the spot' field observation.

Mapping and the visual body

Large-scale maps were essential to ecologists not simply to avoid cartographic over-simplification but as a practical matter of field-mapping experience. The process of mapping and vegetation survey was an active one, which entailed making spatial observations, registered through movement and a kind of heightened attention.[44] This kinetic visual register of ecology was evident in an innovative botanical field-trip, organised by Frank Oliver and Arthur Tansley for advanced students from UCL in July 1903.[45] In what he called 'an experiment in ecological surveying', Tansley led his students to the Norfolk Broads, to study

[42] See chapter 2 on the ecological recoding of photographs from other contexts, such as explorer botany and geology, in the work of Andreas Schimper.

[43] This notion of re-inscription or recodability, as Edwards has pointed out, is underpinned by Arjun Appadurai's influential volume *The Social Life of Things* (1986) which has led to an understanding of objects not as entities of fixed, circumscribed properties and meaning, but as things subject to change and transformation in successive contexts of production, exchange and use (Edwards 2001: 13). The effects of re-contextualisation in photographs has also been noted by others, especially by anthropologists eg. Schwartz 1995; and Morton and Edwards 2009. Specific examples of re-inscriptions are described by Blaikie 2001 and Raiford 2009.

[44] For extended meditations on the relationship between movement, perception and knowledge, see Ingold and Vergunst 2008, and Ingold 2011.

[45] At the start of the 20th century, such field studies were rare in British Universities, whose biology departments were heavily dominated by laboratory studies of species-morphology and physiology, inspired by the 'new biology'.

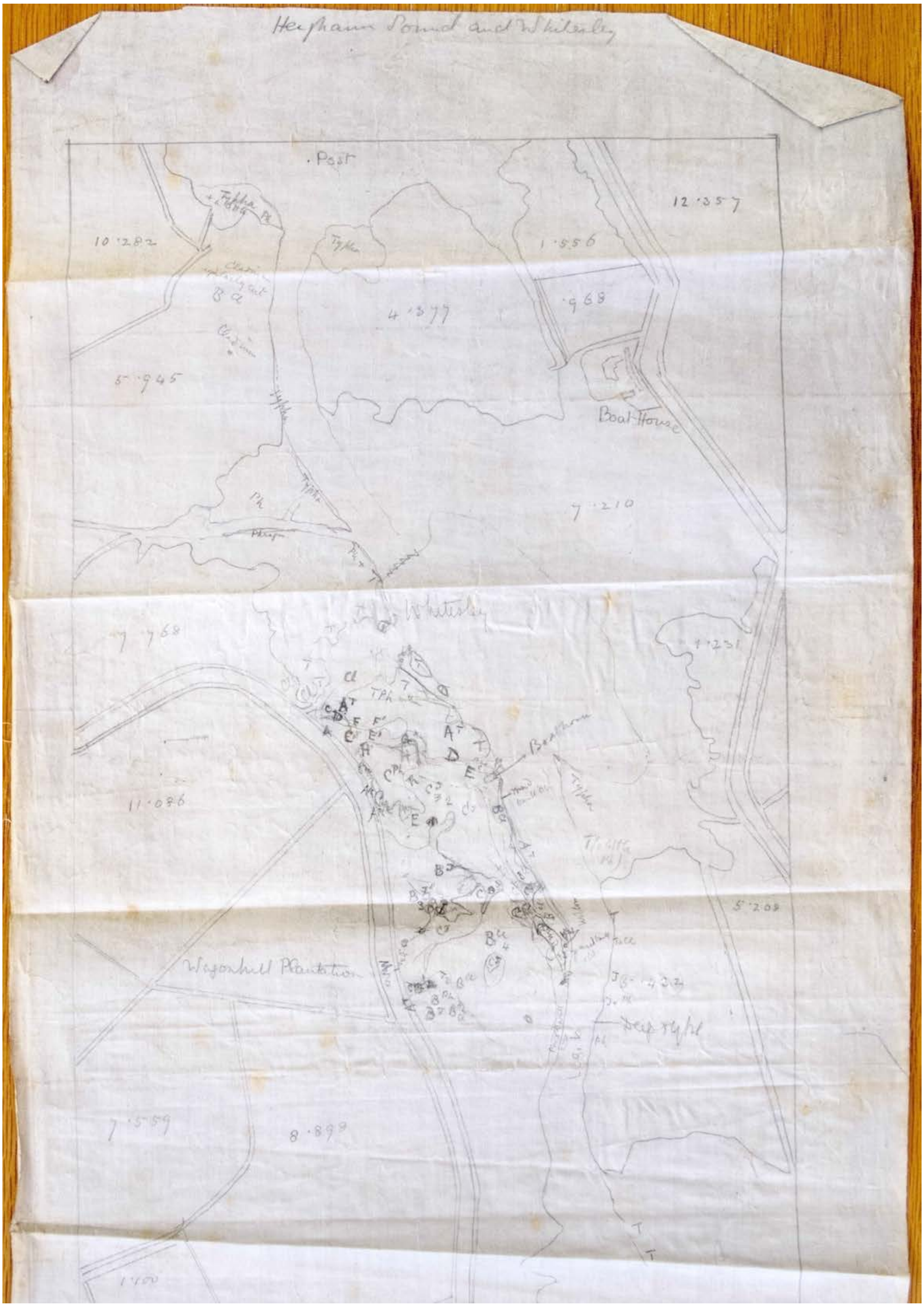

Fig. 5.5. Vegetation mapping on the Norfolk Broads, 1903. Tracing of Ordnance Survey 25" base map. Tansley Papers, Cambridge University Library. CUL/TP/B.75

its plant communities and environment. He had already made advance visits to the Broads the previous summer, and again in May 1903, to familiarise himself with the location, to scout out suitable study sites and to ensure he was familiar with the progress of any changes in the vegetation, before taking his students to survey and map the characteristic plant communities directly. The mapping was undertaken entirely from boats, on which the party lived and worked for the duration of the trip, mapping onto large-scale tracings from the OS 25" (1:2500) map sheets. Tansley considered his 'experiment' a great success and the published account, written from his field notebooks, makes clear that the 'experiment' relied upon the visual quality of the site, where plant communities could be readily distinguished by eye. "The natural 'associations' or communities of plants are well seen," he said.[46]

The exercise began with a process familiarization, collecting and identifying plant material, whilst sailing through the landscape. The party then spent several days concentrating on a more limited area, where "the different 'associations' were recognised and their boundaries approximately traced."[47] At every stage of its planning and realisation, the visual basis for the field-study was evident. As an experienced ecological observer, Tansley first made an appropriate visual identification of the ecological object to be studied, subsequently instructing his students how to see in the same way. It is clear also that the visual cognition thus achieved, and its consequent cartographic record, were possible only by combining observation with movement through the studied landscape, all the while annotating and sketching onto the map (Fig. 5.5).

In order to map the location and extent of objects in the field, by eye, it is necessary to determine accurately one's own bodily (and ocular) location at any given moment, in relation to the surrounding topography. William Smith, for one, was explicit about this necessity. Describing the methods of vegetation survey in 1901, he described the visual and kinetic process of survey.

> The method of survey is to traverse the selected area till its prominent associations are recognised. The extent of country observed in a single excursion is variable and depends on whether the vegetation is uniform and easily accessible, or the contrary. It may be necessary to traverse a difficult area at distances of a few hundred yards, but in parts where the vegetation seen from a

[46] Tansley 1903: 167.
[47] Ibid.: 167.

> distance is found to be uniform the routes may be farther apart. Opportunities of checking previous observations occur when a place already visited is seen from another vantage, or when two routes cross, as they frequently do. In preparing the maps, the limits of prominent associations are ascertained and recorded on the field-map on the spot.[48]

This topographic referencing of the observing body within the landscape required the precise registration of a range of topographic features, and their spatial relationships, relative to the observer and his map. As William Smith indicated in a short paper on *The Use of Maps in Botany* in 1906, the larger scale British Ordnance Survey maps, depicted "contour lines, altitudes, and boundaries, as well as woods and uncultivated land", providing "useful guides in botanical work."[49] The quarter-sheets of the 6" maps were particularly suited to field survey, covering an area of just two by three miles, in a size that could be easily transported and handled out of doors.[50] This use of maps, this movement and observation, contrasts sharply with the practice of a more conventional recording or collecting botanist of the floristic school. Such a botanist might use maps, but chiefly for wayfinding or to confirm the precise location at which a particular plant was found. The floristic botanist's observation would be equally precise but his movement would be very different. His progress would be more intermittent, with periods of walking punctuated by pauses to examine a particular specimen. His attention would be concentrated at his feet rather than to the wider landscape, to individual plants rather than the larger field of vegetation.[51]

In writing of their survey practice, British ecologists like William Smith and Charles Moss accepted implicitly the importance of vision, of the skilled looking required to recognise and map vegetation. Their reports skirted around the visual aspects of field practice, often eliding

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[48] Smith 1902: 137.

[49] Smith 1906: 173. These maps were surveyed at a scale of 6" to the mile (c.1: 10,000) or larger, and widely published at 2½" (c.1:25,000). They showed clear field boundaries and other topographical features, which often (though by no means always) coincided with changes in vegetation type.

[50] The quarter sheets measured just 12 x 18 inches, compared to the 24 x 36 inch full sheet ('Ordnance Survey Maps Six-inch England and Wales, 1842-1952', National Library of Scotland, http://maps.nls.uk/os/6inch-england-and-wales/ [Accessed 09 April 2016]). William Smith (ibid.: 175) remarked on one naturalist who managed to carry the quarter sheets in a 'capacious pocket' but recommended the use of a portfolio for carrying the sheets more conveniently. The coincidence of vegetation with topographic features, especially anthropogenic structures - such as field boundaries, areas of cultivation or pasture, forestry, and managed watercourses - was especially marked in Britain and resulted in much small-scale variation in the landscape. The absence of such features in North American landscapes and in most colonial contexts, where ecological vegetation study could be focussed on apparently natural, large-scale ecosystems, may go some way to explain the rarity of this approach to vegetation survey outside Europe.

[51] Accounts of field excursions from any number of society journals confirm this approach to collecting and observation amongst botanists and naturalists more generally. See chapter 6 for examples of such accounts.

references to 'looking' and 'seeing' with the concomitant action of walking ('traversing') the landscape. This elision had the effect of directing attention towards the supporting data, including species information and environmental observations which, according to Smith, constituted "less apparent but more important work."[52] Scientific data, he believed, would bring clarity and precision to the study of vegetation; it would also engender credibility for the wider project of ecological vegetation survey. Similarly, the theoretically-minded Moss insisted that the vegetation surveyor required 'considerable judgement' to determine which units of vegetation should be mapped, and at what scale; "otherwise, the colours on a vegetation map will be mere empiricisms and without any philosophical basis," he wrote, and "no one can successfully construct a really scientific vegetation map unless he has specially considered the interrelationships of the fundamental units of vegetation."[53] Nevertheless, behind these veils of data and theory, the visual basis for survey practice and ecological knowledge was evident in the embodied processes of field-survey and mapping, which entailed being in, and walking over a landscape, all the while observing and making notes, photographing and sketching the limits of plant associations 'by eye'. The use of large-scale maps and camera, and this manner of field-working, embedded surveyor and map together in the landscape, as the former sought to transfer to the latter his *visual* understanding of the vegetation that gave the landscape its local character. The prominence of photographs, alongside maps, in this first decade of vegetation survey also indicates the provisional and potentially unstable status of vegetation as an object of study (an epistemological instability implicit in Charles Moss's insistence on a philosophical basis for vegetation mapping). Plant associations and the relationships between them were far from evident to common sense. Faced with such uncertainty, when 'writing up', ecologists relied on photographs to provide correlates for their visual encounters with particular stands of vegetation during field-survey and mapping, allowing their readers to see 'at a glance', just as they had seen in the field. Maps and, especially, photographs, provided sensory surrogates for field experience, capable of describing what words could not. As E. Pickworth Farrow, a student of Tansley's, put it "upon visiting the area of vegetation which is to be investigated, the great thing to do is to use one's own eyes."[54] Farrow also underlined the point in a rare statement on photographic

[52] Smith 1902: 137.
[53] Moss 1913: 18.
[54] Farrow 1926: 5.

methods for ecologists, suggesting that photography could overcome the inadequacies of words for describing the complexities of vegetation, because of its visual realism.[55]

For some ecologists, the visual basis for this kind of vegetation study was self-evident. American ecologist Frederic Clements agreed with British ecologists that the maps used for describing the distribution of vegetation types should be as large a scale as practicable — ideally 1:1, he said, though this was "manifestly an impossibility."[56] However, vegetation survey in such circumstances was not, according to Clements, a mathematically precise cartographic method. The value of large scale maps lay in their facility for transcribing knowledge obtained by looking. The recognition and description of plant communities was predominantly a visual matter for which "the plane table and camera are satisfactory substitutes for the surveyor's transit."[57] Clements meant both the straightforward use of a camera to photograph typical examples of vegetation and the combined use of the camera with a plane-table for mapping. The latter would be employed in the usual manner, for sketching topographic features and the various vegetation types present in the view onto a suitable base map. From the same vantage point, using a suitable tripod-mounted camera, a sequence of photographs would be made which could be later combined to provide panoramic views. A complete series of photographs made in this manner was of greater value than the mapping survey, Clements said. Photographic series were much quicker to obtain in the field than a full plane-table survey and the map itself could be accurately constructed later from the photographs and a few notes made in the field.

Whilst he actively encouraged others to do so, Arthur Tansley did not himself publish vegetation maps. He did undertake vegetation surveys, however, usually focussed on specific habitats, such as woodlands or heaths. In 1906, he began to survey the woods close to the home of his wife's family at Branscombe in Devon. His field notes included handwritten observations on the geology and soils underlying various woodlands, together with data on

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[55] Farrow 1925. Farrow studied botany at Cambridge under Tansley, who credited him with being the first to recognise biotic influences on the development of vegetation. Tansley was also responsible for Farrow's interest in psychoanalysis. Both ecologists later published successful books on the subject (Cameron and Forrester 2000).

[56] Clements 1905: 184-186. Borges was not the first to fantasise such a map (Borges 1999). Nor indeed was Clements. Borges' map was an elaboration of one Lewis Carroll had imagined in 1893. Carroll's eccentric 'German' Professor Mein Herr suggests that his country had learned map-making from the British but had taken it much further by making a map at a scale of 'one mile to one mile'. Notably, Carroll's much more sensible English narrator thought six-inches to the mile to be about the most useful scale (Carroll 1893: 169).

[57] Clements 1905: 186.

species-composition, and some additional notes on the relative abundance of the most prominent components of the ground vegetation. For the purposes of field-mapping, he employed Ordnance Survey 6″ quarter sheets, annotating the map sections with species codes to indicate different types of woodland vegetation, firstly in pencil in the field and, subsequently, overwritten in ink to fix a permanent record. For convenience in the field, Tansley cut the map into small sections and mounted them onto card. The resulting map sections were approximately 4½ inches wide by 5½ (sometimes 7¾) inches long, a size that would fit comfortably between the pages of his field notebook (which measured a little over 6″ x 8″), or at least in the same carrying case (Fig. 5.6).[58]

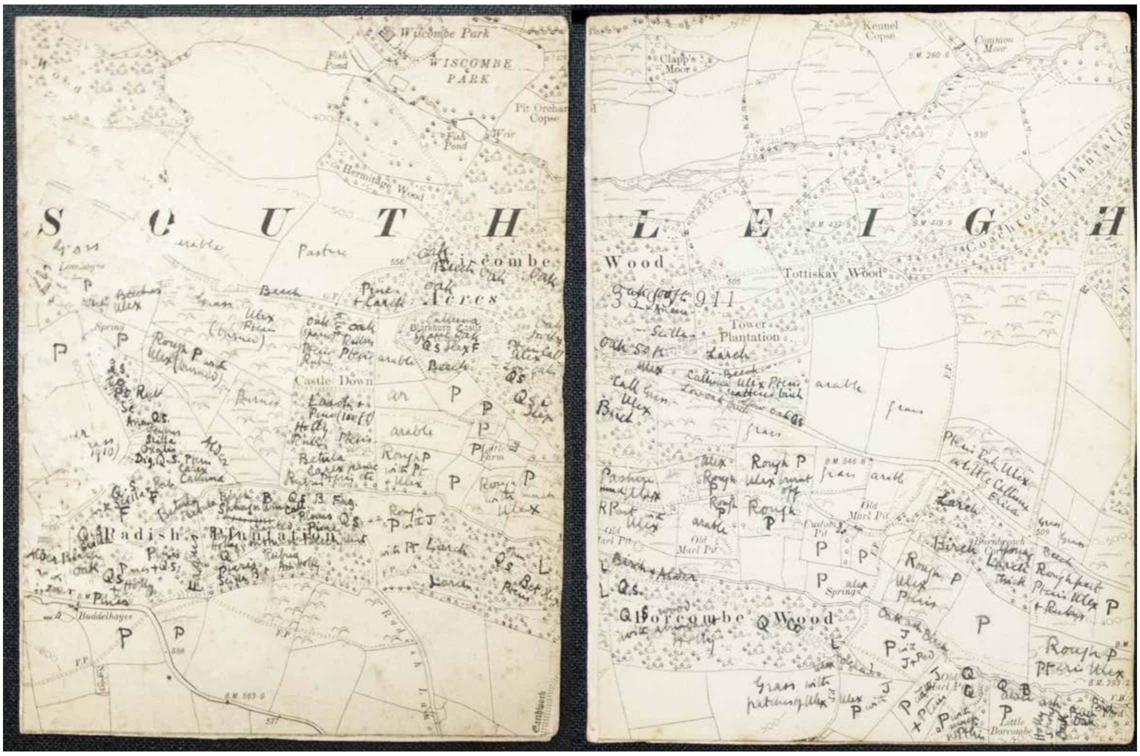

Fig. 5.6. Arthur Tansley's field survey maps from Branscombe, Devon, 1906-08. Ordnance survey 6″ base map, mounted on cards c.4.5″x5.5″. Tansley Papers, Cambridge University Library. CUL/TP/B.84

At this size, a card-mounted map could easily be carried and annotated in the hand, either on its own or together with the field notebook. The notebook could also be used as an additional support when annotating the map. These practical measures for undertaking survey work reflect the realities of long days in the field, in which a surveyor might walk considerable distances, often over difficult ground, and sometimes in inclement weather. A

[58] Tansley subsequently documented this practice in his textbook on *Practical Plant Ecology* (Tansley 1923: 84). Similar practices were also promoted amongst others who used OS maps for survey purposes. eg Edwards 2012a: 66

photograph, taken during a subsequent visit to the Branscombe woods in the 1930s, hints at the embodied cognition entailed in such work. The photograph shows Tansley pausing to make notes as he moves through the undergrowth of a steep, wooded slope. A box or case — which may be a vasculum or a carry-case for other field equipment — is just visible at his feet (Fig. 5.7).

Fig. 5.7. Richard Lythgoe. Arthur Tansley in Seller's Wood, Branscombe, Devon, c.1933. BES Tansley Photographic Collection. LYT/1/10.

These objects and practices of survey, and their photographic record, reveal a very particular way of working in the field, of walking and observing, and of making notes about what the surveyor sees, moving through the landscape. As the anthropologist Tim Ingold says, "to move, to know, and to describe are not separate operations that follow one another in series, but rather parallel facets of the same process."[59] The objects of ecology were recognised and described through such movement and observation. The inscriptive field practices of mapping and photography furnished evidence and record for topographic vegetation surveys, as envisaged by Tansley in 1904, and provided recognition of ecologically defined plant associations as a new object for botanical study. The resulting maps and photographs — whether or not they depict surveyors at work — also reflect the embodied engagement of field-ecologists with visibly recognizable stands of vegetation and places of

[59] Ingold 2011: xii.

scientific interest, within the context of particular, 'known' landscapes. Importantly, the particular forms of movement and observation in ecological fieldwork, especially its visual and instrumental practices, also help to distinguish ecology from floristic botany, with its close focus on individual species rather than vegetation and landscape.

Sketching knowledge

A final illustration of vegetation mapping will help us appreciate more fully the negotiation and appropriation of visual experience in ecological practice, and its expression in cartography. It will also reveal clearly the embodied, visual character of vegetation survey and assist us in understanding the close relationship between vegetation mapping and photography.

In common with all 19th century field naturalists' societies, a primary function of the Yorkshire Naturalists' Union was to organise field excursions. Members would gather, at a particular location, to collect and to exhaustively record the area's flora and fauna. At Whitsuntide 1903 (30th May-1st June), over 100 members gathered for a long weekend's excursion at Filey on the east coast of Yorkshire. With so many present, inevitably the members split into smaller groups, dividing on specialist lines, covering everything from botany to marine algae, fossil-hunting to ornithology, beetles, butterflies and fungi. William Smith at this time was already undertaking vegetation surveys and actively promoting vegetation study among his students and among amateur botanists.[60] He was also an energetic member of the Union and was present among the botanists at Filey as they combed the boulder-clay cliffs for interesting species. His attention was drawn by a series of small ponds with distinctive and attractive vegetation. From his subsequent account, it is clear that his attention was drawn initially by the visual display of the first pond, which was "resplendent with a mass of Bog-bean in flower."[61] Examining this and the other ponds, he noted that, "as one after another pond was visited, it became evident that each had features peculiar to itself and was quite distinct from any of its neighbours." In order to describe the distinctive vegetation of each pond, Smith chose to make simple sketch-maps, depicting the pond outlines and, by means of a range of symbols, showed the different zones of vegetation across each pond (Fig. 5.8).

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[60] See chapter 3, *Amateur associations*.
[61] Smith 1903: 389.

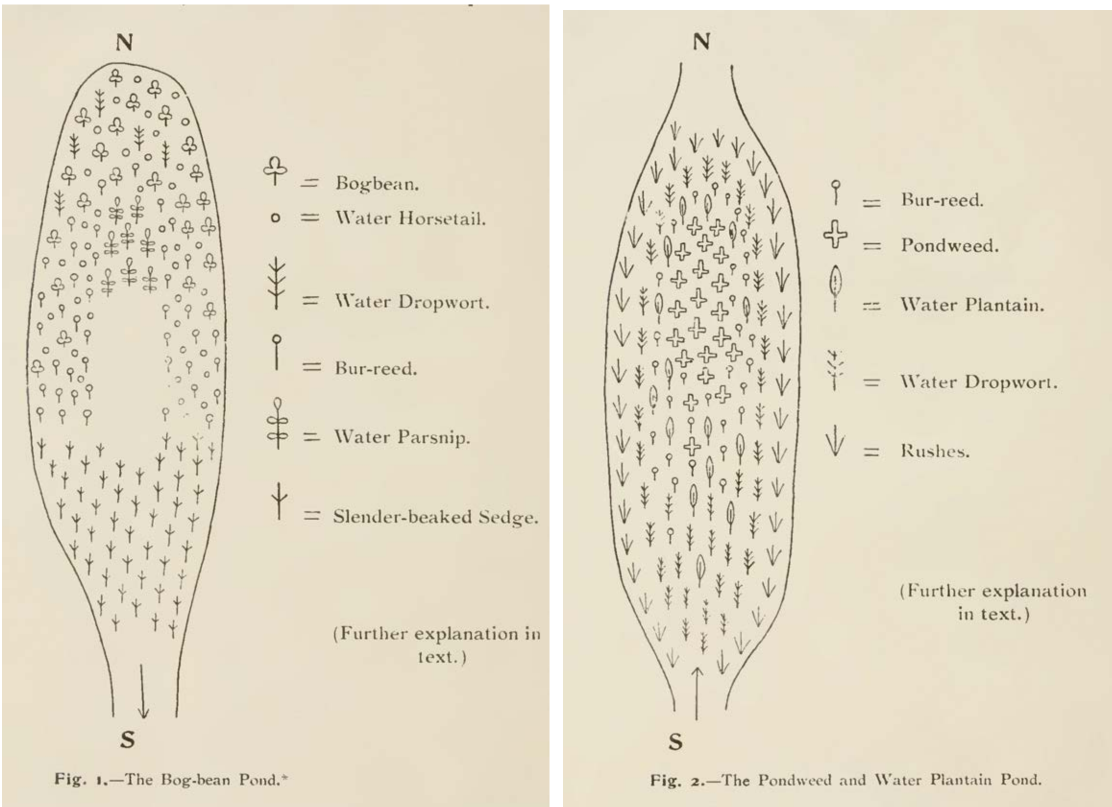

Fig. 5.8. Pond vegetation. From W.G. Smith "Notes on the Vegetation of Ponds." From Smith 1903.

These sketches reveal the problematic nature, both of vegetation as an object of study, and of transposing visual experience to pictorial representation. All maps, including sketches, are abstract visual analogies of spatial knowledge. In Drude's published vegetation maps of Saxony, those of the Smith brothers in Scotland and Yorkshire, or Charles Moss for the Peak District and Somerset, visual abstraction contributes to the intent and reception of such maps as rational, objective representations. However, the work of mapping by eye entails a protracted and cognitively complex series of *subjective* spatial and visual judgements. Firstly, different plant-forms must be distinguished and identified. Their relative frequency and spatial distribution must be assessed, in order to discern their consistent association or grouping into distinct vegetation zones or communities. Once this complex visual and cognitive operation is achieved, further questions arise. How clear a visual boundary can be discerned, for example, between vegetation communities? In practice, such boundaries are never very sharp, since they vary with the distribution of different soils, micro-climate, disturbance effects and so on. Where does the boundary lie exactly at any given point; does the edge turn here or there; should a line be drawn to encompass scattered outliers of characteristic species, or smaller patches of the same community within a different type? All these judgements are necessarily subjective; they must be made 'on the spot', by means of visual estimation in relation to the observer's own body, standing before the object of attention. A second series of judgements is then required to transpose this experience into representation. How should different objects (plants, species, communities, topographical features) be depicted to distinguish each from all the others, in a manner that appears as naturalistic as possible whilst providing clarity for a particular kind of viewer/reader?

All representation is conventional, since it must overcome both the gap between different viewing subjects, and the gap between viewing subject and the object of representation. The aim of representation in these sketches, however, is to direct attention not to itself but to the referent — in this case, vegetation. Pictorial representation here seeks to efface itself, by adopting symbols and applying line and form in ways that are conventional but also partly naturalistic, at least in the eye of the intended viewer. For Smith's pond-maps, the intended viewer is one with an experienced botanical eye. For such a viewer, unlike the linguistic signifier, the symbols used by Smith in these sketches are not wholly arbitrary.[62] The individual symbols used to indicate and separate particular species have been devised and drawn as far as possible to reflect the distinctive growth forms of the species concerned.[63] For instance, in the first sketch, the icon for bogbean mimics that species' distinctive trifoliate leaf-form. That for water horsetail refers to its slender, often leafless, hollow stems, whilst water dropwort and water parsnip share a similar pinnate leaf-structure but are differentiated by the fineness of their leaf-segments. Similarly, in the second sketch, rushes are depicted to reflect their linear, grass-like growth; bur-reed also has linear leaves but is distinguished by the globular flowers and fruits that top its central stem (though unlikely to have been present when Smith made his sketch at the beginning of June). The limitations of this graphical approach are demonstrated by the symbols for water plantain and pondweed, both of which support broad, elliptical leaves. Potential confusion between the two is avoided by rendering pondweed as a simple cruciform shape.[64]

In the practice of hand-sketching 'on the spot', there is a close coincidence, both temporal and spatial, between visual experience, judgement and action. This coincidence has the effect of reducing the distance and abstraction characteristic of more considered, less immediate forms of representation. The coincidence is both epistemological and affective. Smith's

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[62] The arbitrary relations of the linguistic sign have been a foundational principle for structural linguistics since Saussure (1916 [2011]) and are stated in almost every introduction or dictionary of modern linguistics eg. Crystal 2008: 32, 436.

[63] We saw this graphical strategy also in Marietta Pallis's profile of fen vegetation in chapter 4, Fig. 4.11.

[64] Whilst this shape does not in any way resemble the leaf-form of the species in question, in this graphical context, it may at least suggest the plant's habit, which is distinguished by floating leaves.

symbols are schematic, but they are recognisably related to the direct visual experience of the observer/viewer and renders the mapped representation partially transparent. The picture-knowledge of mapping here faces in two directions at once. The vertical projection (plan-view) of the sketches trades on the codes of mathematical cartography and its associated rhetoric of the objective, rational representation of space. At the same time, the iconography of vegetation relies for its interpretation upon a shared subjectivity, a visual recognition of forms that can only be expected of a trained botanical eye. The subjective experience and tacit knowledge of the expert field botanist are implicit but essential requirements for the graphic coding of such drawings, and equally essential for their intersubjective interpretation. Furthermore, as Omar Nasim has demonstrated in relation to 19th century astronomical hand-drawings, sketches of this kind do not merely record observations, they actively construct knowledge. Nasim emphasises a connection between the "exploratory features of the act of drawing [and] ways of seeing and knowing."[65] Such working images are "observational tools in the service of exploration, control, and perception…tools in the service of scientific research that not only direct the sight but internally direct and coordinate the actions of an observer."[66] For Smith the observing illustrator, in this visual exploration of pond vegetation, sketching was itself an observational procedure through which new knowledge may be obtained.

In such contexts, photographs operate in much the same way as sketches, as a constructive form of visual note-taking. Like other kinds of notes, they contribute to what Nasim calls *procedures of observation*,[67] and to the development of the more stable expressions of published accounts. But sketches in this context resemble photographs in more fundamental ways too. I have said that maps are abstract, visual analogies for spatial knowledge. For Nasim's astronomers, and in Smith's sketches, the knowledge represented is itself visual, and the sketches aim to communicate the experience of the observer *in place*, before the object(s) to be described. In such circumstances, the practices of field-mapping and sketching bear a strong resemblance to those of photography. Representation here takes a shift away from the cartographic and the symbolic and towards the pictorial and the mimetic. Smith's sketches are spatial and cartographic, to be sure, but their symbolisation also aims to represent the visual appearance of the plants which occupy his ponds. The symbols resemble

[65] Nasim 2013b: 15
[66] Ibid.: 10-11
[67] Ibid.: 4, 37.

their referents sufficiently to be non-arbitrary; they are recognisable to a trained botanical eye. This operation of *sufficient visual resemblance* is most active in photographs, where the automaticity and optical consistency of the camera-image guarantees a closer resemblance to what the eye can see than in any hand-drawn picture or other graphical form.[68]

The record of resemblances made possible by photography, and its close affinity with drawing, is demonstrated by photographs taken by botanists at other ponds at around the same time as Smith made his sketches at Filey. The first was taken by amateur botanist Dr. Conrad Theodore Green and published in his *Flora of the Liverpool District* in 1902 (Fig. 5.9). Green's photograph gives a lateral-oblique view of the pond, but its similarity to the vertical projection of Smith's pond sketches is evident. Like Smith's drawing, the audience for Green's photograph was one of experienced botanists. Such an audience would be expected to recognise the plant growth-forms occupying the pond, and the characteristic zoning of vegetation around its margins, grading from the upright forms of rushes and other marginal species around the edges, to the mass of floating leaves of water-lilies in the centre. Smith's vertical projection obscures the vantage point of his observation, but it is from just such a view that he would have made his sketch.

A similar effect is intended in the view across a pond in Scotland, from 1913, by Scottish botanist Robert Davie (Fig. 5.10). The zonation of vegetation is less immediately apparent here, but it is still evident to close inspection by a trained botanical eye. Such an eye would distinguish the tall linear leaves of bulrush or reedmace in the foreground from the lower growth of *Stratiotes*, which is the stated subject of the picture, whilst registering also the complexity of the vegetation described in Davie's accompanying article. In the Peircian language adopted by some photography theorists, the shift from the cartographic and symbolic, to the pictorial and mimetic, is also a shift from the iconic towards the indexical. The indexicality of the photograph is its guarantee that what is depicted was really there before the camera. Taken as a guarantee of authenticity in the image and its truth value, indexicality

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[68] Automaticity and optical consistency are the hallmarks of what Daston and Galison (2007) have termed *mechanical objectivity*, which is most convincingly applied to photographic representation. There are inevitable limitations to such resemblance, which should be equated neither with realism nor with objectivity. Together with the photography's putative 'indexicality' the questions of its relation to the real, and to its optical analogy with human vision, persist at the heart of much contemporary photography theory. See, for example, Snyder and Allen 1975; Walden 2008; Walton 2008 on photographic transparency; Barthes 1977; Krauss 1977; and especially Elkins 2007, on photography and the index. The themes are also discussed in one form or another in most recent volumes on photographic theory, including Kelsey and Stimson 2008; Long *et al* 2009; and Emerling 2012.

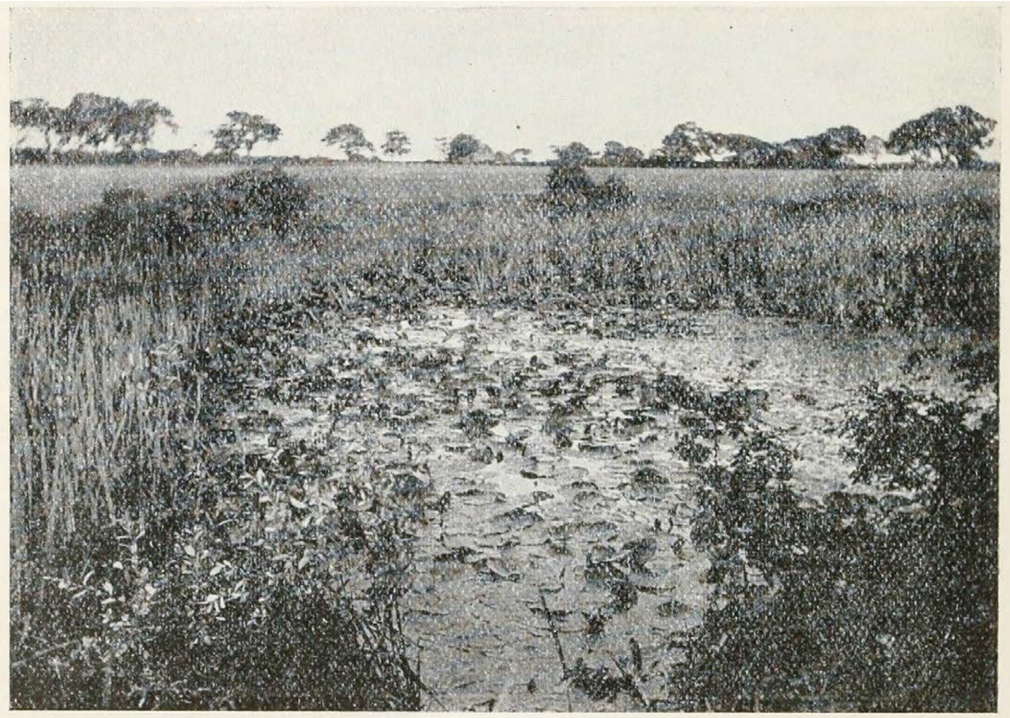

Fig. 5.9. C. Theodore Green. *Water-lilies near Bromborough*, 1902. The Flora of the Liverpool District, in *The Naturalist* (1903: 124)

Fig. 5.10. R.C. Davie. *Photograph of Blackbank Pond with Stratiotes aloides, near Crieff, 1913*. Transactions and Proceedings of the Botanical Society of Edinburgh (1913: 180-183)

is reliant upon the camera's supposed automaticity in the presence of the object of representation. It warrants, as Roland Barthes put it, "that *the thing has been there."*[69] Unlike a photograph, Smith's hand-drawing is not the product of mechanical instrumentation; nevertheless its evidential status arises from the body of the fieldworker as an observer *in place,* and the collateral knowledge of his readers concerning the places and objects represented. Whether in photographs or in Smith's handmade field-sketches, cartography's totalizing 'view from nowhere' is irreducibly rendered as a view of one particular place from another. The view, and the knowledge it yields, whether rendered by hand-sketching or photography, are constructed from the particular perspective of a viewing subject, moving within a landscape. As Tim Ingold has repeatedly argued, movement itself entails making knowledge, about oneself *in* an environment. Ingold insists that ways of walking are always also ways of knowing, even when they appear undirected.[70] In the practices of field-mapping, especially in hand-sketching, and in its cognate practices of photographic record, the view entails *taking a position* in that landscape, describing what one sees from a particular perspective. The move from abstract, geodesic cartography to hand-drawing or sketch-maps is also, therefore, a move from objective representation to subjective experience and reveals the relationship between mapping and field experience as one of embodied cognition and intersubjective visual knowledge.[71]

It should be apparent also that this understanding of the sketch-map, and the field-photograph, is very different from that of Latour's 'immutable mobile', imagined as a sketch of the Pacific Island of Sakhalin, drawn by its 18th century Chinese occupants for French explorer La Pérouse (1741–1788).[72] In understanding the social coherence of knowledge thus

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[69] Barthes 1981: 76. For useful explorations of 'indexicality' and related Peircian language in photography theory, see Scott 1999 and Elkins 2007.

[70] In Ingold's words, "people's knowledge of the environment undergoes continuous formation in the very course of their moving about in it." (Ingold 2000: 230); and "...walking comprises a suite of bodily performances that include observing, monitoring, remembering, listening, touching, crouching and climbing. and it is through these performances, *along the way*, that their knowledge is forged." (Ingold and Vergunst 2008: 5)

[71] This is not the place to consider them, but what I assert here has important implications for understanding the practices of cartography more generally, by bringing to attention those practices and operations of field-mapping that are rendered invisible in the rational cartographic product — the printed map. Such a map, according to Michel de Certeau, which presents itself as "a totalising stage on which elements of diverse origin are brought together to form a tableau of a 'state' of geographical knowledge, pushes away into its prehistory or into its posterity, as if into the wings, the operations of which it is the result or the necessary condition." (Certeau 1984: 121)

[72] Latour 1990. The sketch was made first in sand and then on paper, La Pérouse to carry home to his King, Louis XVI. Latour's paper has been highly influential, especially for its insight into the rhetorical force of visual representation and other forms of 'inscription' in fixing factual knowledge. Inscriptions

brought 'back home', Latour insists that "it is not perception which is at stake in this problem of visualization and cognition."[73] Rather, it is at the social level of rhetorical presentation — one speaking, writing or showing for others — that visual representations become immutable, mobilised in diverse contexts to persuade others of the apparent facts. But at the level of vegetation survey practice, its mapping and photography, what was precisely at stake *was* the intersubjective perception of botanically trained observers. Only through shared visual cognition, obtained and practiced in the field, could ecologists come to a common understanding of the nature of vegetation. It is important to maintain this distinction between the function of photographs, sketches and maps as immutable mobiles and their application as observational tools. In the former, they provide rhetorical tools for socially coherent knowledge formation. In the latter, they function to structure scientific knowledge at the level of individual visual (field) encounter, mediated by the intersubjective experience of a community of similar, scientifically-minded observers. Smith's Yorkshire pond sketches are capable of functioning as immutable mobiles. Indeed they did so when Smith re-published them, out of context, as illustrations to a paper on Scottish vegetation.[74] In their new context, Smith used the sketches to illustrate the visible zoning of vegetation in ponds, and as an example of how it might be represented. However, he presented the sketches in lieu of adequate drawings from the particular Scottish context under description, because no such drawings had been made. In their original context, the drawings were intended to describe real plant communities as they were encountered in the field, in a specific place and time. In this new context, the sketches do not fix the representation of any such communities, because they are *out of place* and *out of time*. Indeed, the representational specificity of such sketches is still more geographically and temporally located than this simple re-contextualisation might suggest. Ecologists' underlying assumptions regarding the dynamic and developmental aspects of vegetation were built-in to pictures of this kind. They could be read as contingent representations, showing the character of vegetation at the time the sketch was made, in the full knowledge that the structure, composition and appearance of the vegetation were subject to constant change.

For ecologists, these assumptions regarding the specificity of vegetation, as well as its the dynamic and mutable character, were readable also from photographs. This is especially

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become 'immutable mobiles' when they are abstracted from their origins and re-presented to persuade others of the knowledge they purport to have 'figured out' so to speak.

[73] Ibid.: 26.

[74] Smith 1905d.

evident in representations of wetland successional or seral vegetation, as in William Smith's Yorkshire ponds, or in photographs like those of Marietta Pallis on the Norfolk Broads (chapter 4, Fig. 4.12). It is no less true, however, of ecological photographs in more stable forms of vegetation such as mature woodland (Fig. 4.10, 4.22), whose stability was merely relative and gave rise, nevertheless, to considerable variation between different examples of similar vegetation types. The geographical and temporal specificity of the image, its 'on the spot' registration by the ecological surveyor, were its guarantees of evidentiary value — a virtual witness for the experience of the scientifically observing body.[75] The camera's mechanical objectivity also shored up the testimonial worth of such visual representations. But a purely visual account could never do justice to the unstable object of vegetation, whose appearance could be expected to vary considerably over time, and between different stands of the same type. For this reason, as we have seen repeatedly in the context of ecological vegetation study, photographs accompanied other forms of observation and data, whose mutual corroboration was required in providing evidence for real plant communities encountered in the field.

Walking and looking: estimating abundance and characterising vegetation

Ecological mapping, then, was routinely associated with sketching and photography. Maps and photographs were the essential outputs of primary vegetation surveys and were considered the direct transcription of scientific observation in the field. Nevertheless, maps and photographs alone were insufficient to fix the epistemologically unstable units of vegetation. When Arthur Tansley began to promote vegetation surveys as the fundamental work of ecology in 1904, like the Smith brothers, he did not make clear how plant associations might be recognised and distinguished from one another in the field. Rather, he characterised the work of vegetation survey as visual and intuitive. Equally intuitively, he recognised that ecologists needed some other means to fix the character of the resulting categories of vegetation, so that they might be described and recognised in turn by others. Plant associations must be thoroughly "characterised, enumerated and described."[76] Observations should encompass variation both within and between plant communities, and the intermediate transitions between adjacent types. In the first decades of the 20th century,

[75] The phrase 'virtual witness' was coined by Steven Shapin and Simon Schaffer (1985: 60-65) to indicate the verbal or pictorial strategies by which scientists engender trust and conviction in their observations. Jennifer Tucker (2005) has applied the notion of 'virtual witnessing' more directly to the reproduction and circulation of scientific photographs.

[76] Tansley 1904a: 195.

ecologists struggled to find the right means to meet this need to describe and classify the range of vegetation characters that seemed so evident to intuition. The solutions they settled on were intended to gather objective quantitative data in answer to questions about the character and ecological functioning of vegetation. Even as they sought to ground their science in objective data, however, the methods they developed turned out themselves to be strikingly dependent upon subjective judgement, visual methods of observation, and the use of photographic record.

The most obvious variations in vegetation were clearly related to physical habitat differences, including geology, temperature, soil characteristics, water relations, and derivative biotic factors such as shading, resource competition and so on. For many of the earliest ecologists, these fundamental habitat factors drove vegetation development and constrained the possibilities for character and variation amongst plant communities. "No one can doubt that ecological problems are at bottom physiological problems," claimed Tansley and his colleague Fritz Blackman in 1905.[77] However, the physiological responses of plants to these environmental factors were complex and very poorly understood, and offered little help in characterising vegetation as it appeared to the eye.[78] In lieu of a full understanding of the complex environmental responses of plants, some turned to a consideration of the different growth forms of plants within vegetation, since different species often develop similar plant-forms in response to similar environmental pressures. This had been the basis for Humboldt's visually driven classification of vegetation types, and those of many of his 19th century successors. The gross morphology of plants was immediately apparent, without the need for complex physiological investigations. Moreover, growth form could be considered an evolutionary response to the influence of environmental factors. But in practice, similar growth forms occurred not only among different species, but in different kinds of vegetation, often under widely different ecological conditions. Such an approach would be unhelpful, Tansley complained, since "if

[77] Blackman and Tansley 1905: 202.

[78] Proponents of a vegetation description and classification based on habitat factors included Warming 1895, 1909; Flahault 1897; Schimper 1898; Clements 1904, 1905, 1916; Blackman and Tansley 1905; Moss 1910; and Tansley *et al* 1911a. The complexity of physiological responses to environmental conditions gave rise to such uncertainty with regard to the identification of plant associations that some were inclined to reject completely the community approach to classification. The so-called 'individualistic concept of vegetation', championed by American ecologist Henry Gleason, was an attempt to take such responses more clearly into account when seeking to understand the character and development of vegetation (Gleason 1926).

we used plant-form as the basis we should associate units of vegetation which are naturally distinct, and divorce others which are naturally associated."[79]

Ecologists were inevitably thrown back on the only other kind of data available — the details of floristic composition. Each stand of vegetation, or its corresponding plant community, could be described by its characteristic assemblage of plant species. Species information was already available for many kinds of vegetation, and was readily understood by other botanical workers. However, a simple floristic approach was no less problematic than one based on growth-forms. Any given stand of vegetation could not be adequately characterised by a simple listing of species, especially if comparisons were to be made between different stands, since different types of vegetation contained many of the same species. A floristic approach based solely on species-listing was precisely the kind of botanising that gave rise to the epistemological problem faced by vegetation workers. For all these reasons Tansley, who began by believing that "habitat must be the basis of any natural classification of vegetation,"[80] ultimately concluded that "floristics, life-form and habitat are all essential objects of synecological study, but none is sufficient to serve as a basis of classification. Classification must be based primarily on the sum of the characteristics of vegetation itself."[81] The answer was to refine floristic data to take record not only what species occurred where, but which species occurred in consistent association with one another, and their relative abundance in the resulting vegetation communities. In essence, this meant making some form of quantitative measure for each of the species occurring within a plant community. In defining the term *plant association* in 1909, therefore, Eugene Warming agreed that, "in studying the vegetation of a certain area from a floristic and geographical standpoint, it is necessary to define the relative numbers of the various species."[82] Like Tansley, Frederic Clements observed, in the "recognition of formations…no one of the three viewpoints is adequate alone or primarily." Nevertheless,

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[79] Tansley *et al* 1911a: 14. Despite Tansley's misgivings, this approach has been a persistent one, and ecologists had good historical warrant for the method. Growth-form provided the basis, in part at least, for most 19th century vegetation study, including Humboldt, Grisebach, Kerner, and Schimper (Whittaker 1962: 6), as well as aspects of the work of Warming (1895) and Drude (1913). The approach had its first fully systematic statement by Danish ecological botanist Christen Raunkiaer in 1905 (Whittaker 1962). It has undergone considerable development since, with recent variations tending to refer to 'plant functional types' rather than Raunkiaer's original 'growth-forms' (Duckworth *et al* 2000; Diaz *et al* 2004).

[80] Tansley *et al* 1911a: 13.

[81] Tansley 1920: 146.

[82] Warming 1909: 139.

he also agreed with Warming plant associations "differ in floristic and to a certain though unknown degree in habitat. Hence they are recognized chiefly by floristic differences."[83]

The brothers Robert and William Smith had already taken preliminary steps in this direction, in their vegetation surveys in Scotland and Yorkshire. Robert Smith had begun in 1896 by making aggregated lists of species, divided according to their relative frequency within particular kinds of vegetation. Dominant species were listed separately from other frequently occurring species within the same community, and others that were consistently associated but occurred only rarely. In the absence of a developed classification for different vegetation types, however, the kinds of association Smith recognised were imprecisely drawn. The relative frequency of species, broadly estimated and synthesised from numerous field surveys to define different plant associations, was difficult to apply to specific stands of vegetation. His estimations of abundance for each association were also inconsistently expressed, sometimes separating lists into dominant, frequent and rare species; sometimes presenting a single list in a rough order of abundance.[84] By 1903, William Smith progressed, though still inconsistently, to annotating individual listed species with an indication of frequency. The terminology he used to describe frequency remained variable, however, and did not always distinguish between a species' constancy (the reliability with which it can be expected to occur within a particular vegetation type) and its abundance or level of cover.[85]

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[83] Clements 1916: 123; 128. For classifying vegetation types, continental European ecologists, on the whole, leant more towards floristic accounts (eg. Drude 1913; Gradmann 1909). British and American ecologists laid more stress upon habitat factors and physiological investigation (eg. Clements 1904, 1905, 1907, 1916; Moss 1910; Tansley *et al* 1911a; Yapp 1922b), but there was a high level of agreement that plant associations could be most readily recognised by their floristic characteristics.

[84] Smith and Moss 1903; Smith and Rankin 1903; Smith 1900a, 1900b. In some cases, Smith separated lists into plant-forms, such as "grasses" and "general pasture plants", or according to primary habitat features, such as "plants occurring especially where rock near surface", or "peat plants" growing in dry or moist conditions respectively; and those species that seemed to be confined to particular, geologically defined regions.

[85] Smith 1904, 1905d, 1905e. He recorded species variously as "usually dominant", "sometimes dominant" or "sub-dominant", as present "occasionally", or "sometimes", and as "often abundant", "not abundant", "common", "few", "rare" or "very rare"; whilst elsewhere he reverted to simple species lists, noting only dominants and species of rare occurrence and, on occasion, a species' association with particular habitat conditions. In the years following the Smiths' Scottish and Yorkshire surveys, practice continued to vary, from species-lists grouped according to abundance categories, to tabulated lists with abundance estimates for each species in different vegetation. For examples of these, see Moss 1907 and Watson 1909 respectively. Tabulation of species along plant community lines seems to have developed independently in Britain but was proposed also by Finnish ecologist Aimo Kaarlo Cajander (1879-1943) in a classification of forest types (Cajander 1903, cited by Whittaker 1978: 93). Van der Maarel 1975 suggests that similar tabulations were practiced by Swiss botanists Friedrich Stebler (1852-1935) and Carl Schröter (1855–1939) in a paper of 1893, which he considered significant for the development of subsequent Swiss floristic phytosociology under J. Braun-Blanquet (1884–1980).

Despite a halting start, however, this approach of annotating species lists with estimates of relative abundance came to be standard practice among British ecologists within just a few years. By 1911, an informal consensus had emerged and the influential compendium of *Types of British Vegetation*, written by the members of the BVC, employed abundance estimates and a standard notation almost throughout.[86] Thereafter, the practice was widely adopted and increasingly standardised. As early as 1914, in publications directed at an informed ecological readership, a standard scale of abundance could be used without explanation and, by 1922, model papers in vegetation ecology included exhaustive species lists, tabulated and annotated according to a common standard.[87] The use of comparative measures of abundance for recording and describing plant communities received little direct comment from early practitioners. There was no apparent formal dialogue or agreement on estimating abundance, or its notation. No authoritative guidance was issued by any one ecologist or group. As a methodological practice, it seems to have developed piecemeal, in response to the experience of observing and recording vegetation in the field.[88] Nevertheless, with minor variants, the practice quickly became ubiquitous and, like the pervasive use of photography, became a largely unexamined orthodoxy amongst ecologists at this time. The use of the so-called DAFOR abundance scale has been a standard practice among British ecologists ever since.[89]

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[86] Tansley *et al* 1911a: xi-xii. The standard abundance scale, now commonly referred to as the DAFOR scale is as follows: D=Dominant, A=Abundant, F=Frequent, O=Occasional R=Rare, (L is sometimes added to indicate a localised distribution). Minor variations in the use of the scale — additional or alternative terms, such as 'co-dominant' and 'scarce' — or the addition of modifiers like 'very', are further indications of the informal development and adoption of the practice.

[87] Matthews 1914; Salisbury and Tansley 1921; Adamson 1922.

[88] It is possible to trace this development in abundance estimation in the field-notebooks of individual ecologists from this period. Like any botanically trained ecologist of the time, Arthur Tansley's notebooks contain discursive notes, observations and sketches about the flora, vegetation and topography of particular sites. These are occasionally supplemented by more precise notes concerning soil data, or plot numbers for locations subject to more detailed recording. However, the bulk of pages are taken up by lists of plants. Notes from 1908 and earlier generally comprise simple lists, perhaps indicating dominants but with no comparative indications of abundance for associated species. In notes from an excursion to Aviemore in Scotland in 1910, Tansley included similar lists but annotated them with an irregular scale of abundance, using abbreviated terms such as 'dom.' for dominant, 'o' for occasional and 'f' for frequent – but also 'scanty', 'ab.' for abundant, and 'v.ab' (CUL/TP/B.21). One notebook contains observations from both 1908 and 1918-19. Here, only simple lists appear in 1908 but, by the later date, Tansley was clearly using the standard notation he had described in Types of British Vegetation (CUL/TP/B.14). The development and role of informally derived practices of this kind deserve more attention; they indicate a largely unseen social mediation of science and scientific method, in which informal and largely unrecorded communications affect both personal and accepted disciplinary practice.

[89] Statistical methods for estimating species abundance in vegetation were subsequently refined by European plant ecologists, especially the Swiss botanist J. Braun-Blanquet (1884–1980) and Czech

Attaching estimates of relative abundance to species lists in this way was expected to provide consistency and a greater degree of objectivity in vegetation surveys and, however informal its progress towards a standard methodology, it was a significant refinement in the development of vegetation ecology. It facilitated clearer characterisation of plant communities, and helped to distinguish plant ecology from a 19th century geobotany focussed on individual species-distributions. However, as this short history of reveals, the judgements required to apply a system of abundance notation were neither objective nor truly standardised. Estimations using the DAFOR scale were not based on counting plants, or any other accurate quantitative measure; rather they were derived from the subjective visual judgement of an ecologist in the field, *walking through* and *looking at* the vegetation. Photographs were of limited help in communicating such judgements, but so were species-lists annotated according to subjective assessment in the field. Ecologists routinely carried a camera in the field, routinely they made photographs, annotated species lists and sketched vegetation maps. All three of these they reproduced in the published accounts of their survey work, in an effort to give both visual substance to their observations, and rational support for the subjective visual cognition of work in the field.

Looking and counting: mathematical vision

Ecologists were under no illusions about the imprecision of survey methods founded on subjective estimation. For the most part, the methods of vegetation survey and mapping I have described so far were intended as rapid reconnaissance studies. They were expected to provide a general overview of the subject and to help direct more intensive investigation. Arthur Tansley said as much in his first manifesto for vegetation survey work in 1902.[90] He distinguished the essential but preliminary *descriptive* stage of ecological survey from the subsequent *experimental* and analytical work, which was required to take ecology "beyond the intuition of the gross appearances of what we see around us, to enquire as to their causation."[91] The two stages were logically separate, and Tansley pressed home the distinction repeatedly in subsequent publications, but he did not mean that the two stages of inquiry need be separate in practice — indeed, Tansley insisted, the two should be progressed

botanist Karel Domin (1882-1953), both of whom gave their names to widely used scales of abundance. The DAFOR scale remains in use, however, as a rapid estimation method for general vegetation survey.

[90] Tansley 1902a.

[91] Tansley 1904a: 196.

hand-in-hand. It did, however, require the development of different methods of investigation.[92]

In the world's first published text on ecological methods, in 1905, American ecologist Frederic Clements echoed Tansley's two stages by drawing a line between *reconnaissance* and *investigation.*[93] For the purposes of *reconnaissance* vegetation surveys, Clements maintained, mathematical accuracy was not required in depicting the boundaries of different vegetation types. He appreciated the value of such descriptive ecology, but he also considered its superficial accounts of vegetation far too restricted to answer fundamental ecological questions. He feared that the ease with which floristic botany could be turned to vague ecological description had resulted in "scores of so-called formations...which have no existence other than in the minds of their discoverers." Photography was partly to blame, he said. "The misleading definiteness which a photograph seems to give a bit of vegetation has been responsible for a surplus of photographic formations, which have no counterparts in nature."[94] The evidential weight of photographic records, their persuasive force in presenting plant communities as recognisable objects for study, according to Clements, was bringing ecology into disrepute. It was too easy to draw a line on a map to indicate an area of vegetation, draw up a species list and take a photograph, claiming to describe a recognisable plant community. Floristic botany and photography were both indispensable to systematic vegetation study, he insisted — both receive considerable attention in *Research Methods* — but the proper investigation of plant communities also required more 'exact methods'.[95] These must be directed not only at the physiognomy or appearance of vegetation, or its species composition, but to the detailed study of its structure and development, and to its physical habitat conditions.

The investigative strategy proposed by Clements was comprehensive, encompassing a wide range of methods, tied to a broad scheme of scientific instrumentation. In addition to photography and cartography, he promoted the use of psychrometers for measuring atmospheric humidity, automatic photometers (using photographic papers) to make standardised estimates of light intensity, equipment for soil sampling and analysis, thermometers and thermographs, barometers, rain gauges and anemometers, clinometers, and trechmometers (for estimating water run-off and infiltration). A number of these, he

[92] Tansley 1923: 69-74; Tansley 1947: 132-3; Tansley and Chipp 1926 Tansley and Chipp 1926: 35 et seq
[93] Clements 1905: 8
[94] Ibid.: 7.
[95] Ibid.: 161.

suggested, could be usefully combined, in banks or arrays which he christened 'ecograph batteries', deployed across a range of habitat conditions.[96] He also recommended the use of natural instruments, such as living or dry-pressed specimens to make leaf-prints on photographic paper, for making comparative measurements of light transmitted through their epidermal surfaces. It is a list of instruments that Humboldt would have given pride of place in his inventory of equipment for transport across South America a century earlier. Similar calls for quantitative methods were also soon arising in Europe. Danish ecologist Christen Raunkiaer (1860-1938) was especially emphatic about the importance of finding "a method of improving upon the uncertain picture we obtain by subjective estimates of plant communities."[97] For all the complexity of procedure and instrumentation proposed by Clements, it was his simple solution to this problem of estimating species abundance in plant communities that had most impact on the subsequent development of ecological methods.[98]

The problem, and its solution, were suggested to Clements and his colleague Roscoe Pound in 1897, by their experience of botanical survey in Nebraska.[99] The immediate stimulus to innovation was the difficulty of assessing by eye the relative frequency of species within prairie grassland 'formations'. Up to this point, they had been accustomed to making purely visually assessments of the abundance of different species in different types of vegetation. In the case of neighbouring prairie-grass and buffalo-grass formations, however, whilst they could discern two distinct communities, the transitions between them were subtle and extended, and it was difficult to draw a clear line to separate the two. To overcome the problem, they decided to concentrate attention more closely on small samples of vegetation in these transition zones, to determine where one community gave fully onto another. In doing so, they discovered that their visual judgements had been faulty. A number of visually prominent species, which appeared relatively numerous to the eye, turned out to be much less abundant than they seemed. Correspondingly, the abundance of less conspicuous species was likely to be underestimated in a general visual assessment. The resulting, subjective estimations of secondary species could mask the underlying transition from one plant community to another. A more quantitative method was required, to characterise and contrast the relative abundance of species present in these neighbouring plant communities.

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96 Ibid.: 92.

97 Raunkiaer 1934: 203.

98 Clements's regime of instrumentation and many of his methods (though only a few of them actually originated with Clements), provided the model for subsequent textbooks of ecological methods for several decades, including European examples such as Rübel (1922) and Tansley (1923).

99 Pound and Clements 1898.

Seeking a solution to this apparently local problem for vegetation surveys in the prairies, Pound and Clements hit upon their so-called 'quadrat-method', which turned out to have a much more general application.

As its name suggests, a quadrat is simply a square, marked out to define an area for precise recording of plants and vegetation cover. The size of the quadrat proposed by Clements in *Research Methods* was variable, depending on the scale of the vegetation under observation. So, for woody species in forest vegetation, a 50m square was appropriate, whilst a finely-structured grassland may require a quadrat no more than 1m x 1m. In its simplest form, which Clements designated a 'list quadrat', all the plant species present within the square were simply listed, and the number of individuals of each species counted. In its most detailed and, as far as Clements was concerned, its most useful from — the 'chart quadrat' — the vegetation within the square was accurately mapped on scaled plotting paper (Fig. 5.11).

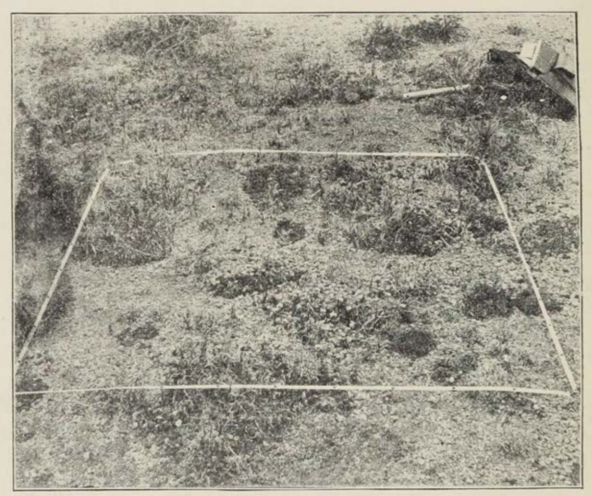

Fig. 51. Permanent chart quadrat, *Andosacile, Carex-Campanula-coryphium.*

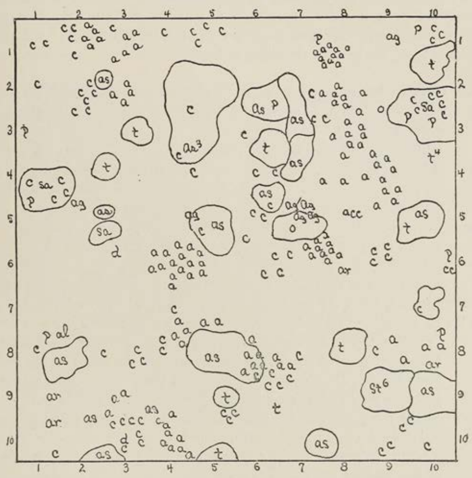

Fig. 52. Chart of the quadrat shown in figure 51. Legend: a, *Androsace chamaejasme*; c, *Carex rupestris*; t, *Tetraneuris lanata*; p, *Potentilla rubricaulis*; as, *Arenaria sajonensis*; ar, *Artemisia scopulorum*; ag, *Agropyrum scribneri*; sa, *Silene acaulis*; st, *Sieversia turbinata*; d, *Dasyphora fruticosa*; al, *Allium reticulatum*; o, *Oreoxis alpina.*

Fig. 5.11. A typical chart quadrat. From Clements 1905: 168-9.

If still greater precision were required, the exact number and location of every plant within the quadrat could be determined and plotted. Quadrats could be recorded as instantaneous 'snapshots' of vegetation or, for more considered and longer term studies, they could be permanently marked for repeated survey, to detect and monitor change and development in the vegetation from season to season or from year to year. By counting individual plants within quantifiable areas in this way, much more precise assessments of absolute and relative species cover and abundance were possible.[100]

In his history of American ecology, Ronald Tobey proclaimed the quadrat method as a revolutionary "leap to numerical quantification in ecology," in which ecological science left behind a 19th century 'sensory typology' of vegetation. According to Tobey: "The invention of the quadrat, or meter-plot, embodied a profound epistemological shift, in which the scientists ceased to believe in the reality of one phenomenon and began to believe in the reality of another phenomenon. Ecology had 'taken leave of its senses,' and hitched its intellect to mathematics."[101] This shift, he claimed, was analogous to Copernican and Galilean revolutions in astronomy and the study of motion or, more startlingly still in a biological context, the Darwinian shift to a theory of natural selection. Tobey's attempt to apply a Kuhnian analysis of paradigm shift to the quadrat method should perhaps be taken as rhetorical flourish for a technique that turned out to be amongst the most pervasive tools of ecological inquiry of the 20th century. As others have pointed out, however, despite his emphatic promotion of quantitative methods, Clements' own work showed little real concern with mathematical approaches, or even simple statistical treatments. Rather, as Malcolm Nicolson has said, "his methods remained essentially descriptive and observational."[102] The same was true of most of his ecological contemporaries during this early phase of the new science's development.[103] Henry Cowles (1869-1939), another founding figure for American ecology, preferred to rely on

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[100] Clements 1905: 164. Arthur Tansley (1904a) correctly predicted that Clements' methods would "become an indispensable means of investigating the phenomena of vegetation". The quadrat and today remains a fundamental technique for recording vegetation and other immobile organisms (Sutherland 2006), and has been widely applied in other fields of survey and monitoring, from geology (Coe 2010) and soil science (Robertson 1999) to archaeology (Banning 2002; Lucas 2001).

[101] Tobey 1981: 68.

[102] Nicolson 1988: 194. Malcolm Nicolson suggests that Clements' advocacy of quantification should be regarded more as a rhetorical device intended to advance the professional and disciplinary standing of ecological science than a real methodological shift. See also McIntosh 1985: 134.

[103] Notable exceptions included American botanist Henry Gleason, who quickly focussed on the numerical aspects of the method, making counts and analysing relative frequencies in a manner similar to the botanical arithmetic applied to much larger areas by 19th century floristic biogeographers (eg. Hart and Gleason 1907; Gleason 1910, 1920, 1925). (See also nn. 94 below.) Danish ecologist Christen Raunkiaer went considerably further than Clements in developing and publishing statistical methods for vegetation study as early as 1908 (eg. Raunkiaer 1934: 111; 201). Others, such as Oscar Drude, Josias Braun-Blanquet (1884–1980), and Karel Domin (1882-1953) developed numerical scales for estimating abundance within a quadrat. The latter's 10-point scale remains in common use today. It should be noted also that statistical methods in ecology were much better developed in relation to marine biology and limnology than in plant ecology. In marine studies and early animal ecology, counts of organisms obtained through sampling were the only community data available. See McIntosh 1985: 107 *et seq* for a fuller account of early developments in quantitative community ecology.

his own experienced eye. He was not unusual among his fellow ecologists when he wrote to Arthur Vestal that, "Personally, I do very little quadrat counting, even when I am working intensively on a small area. I believe I have rather more confidence in a subjective method than in an arbitrary method like the quadrat. After all, one must select one's quadrats, and that brings in the subjective element."[104] Another American ecologist, Henry Gleason, expressed misgivings, specifically, about this subjective basis for quadrat selection, and the application of the method for describing whole pant associations, unless quadrat records were taken in large numbers and subject to statistical analysis.[105] Nor indeed did other, overtly subjective measures of abundance and description disappear. Ever since their introduction, the DAFOR system, and other semi-quantitative measures of relative abundance, have remained central to reconnaissance surveys, even in relatively detailed ecological investigations.

The claim that Clements' methods amounted to epistemological revolution becomes still less tenable when considered within the wider frame of contemporaneous scientific practice. Clements' development of quantitative and graphic methods is better seen in the context of broader scientific developments in the graphic representation of geometrically defined space, by means of coordinate systems and graticules. Such methods became apparent in a number of developing disciplines around this time, from astronomical mapping to forensic science and archaeology, reflecting a more general mathematisation of space and its cartography. Barring differences in the graphic symbols used, the resulting squared visions for charting and counting stars or forensic patterns of dust can bear a strong resemblance to simple botanical quadrats, drawn after Clements had introduced the method to a more general constituency of botanical ecologists. This tradition makes it apparent that Tobey's diagnosis of Clementsian methods as a rejection of the visual basis for ecological knowledge is also seriously mistaken. In characterizing quantitative ecology as a rejection of the 'sensory typologies' of 19th century biogeography, Tobey conflated visual methods with typological thinking and assumed that ecologists rejected both.[106] In fact, despite his injunction towards quantitative methods,

[104] Henry C. Cowles to Arthur G. Vestal, 26 June 1914; quoted in Kohler (2002a): 106, n.17.

[105] Gleason 1920: 23. Henry Gleason (1882–1975) was a taxonomically trained botanist and ecologist who followed Clements and Cowles in his early understanding of plant communities and applied broadly similar methods in his studies of vegetation. He subsequently become known as the most significant dissenting voice to the mainstream of Clementsian ecology in America, opposing Clements' organismic concept of plant associations with his own 'individualistic hypothesis' of vegetation development (Nicolson 1990).

[106] The effect of Tobey's claim is to extend the 20th century 'denigration of vision' to ecological science. See Martin Jay (1993) for an analysis of this tendency in 20th century thought.

Clements' own account of the quadrat is anything but a rejection of visual science. Like other early 20th century ecologists, Clements wished to find more reliable ways of understanding and communicating the character of vegetation, its composition and structure. They were also keen that their science should be regarded as objective and quantitative, in keeping with the general trend of late-Victorian and Edwardian biological science, which struggled to keep pace with the reputation of the more exact physical sciences. But this did not mean that they rejected visual methods, or that they discounted the knowledge obtained through visual research. In ecology, as in archaeology and astronomy, photographic record remained central to quantitative methods. In a manual of archaeological methods, published the year before Clements' *Research Methods*, Flinders Petrie described the practice of drawing plans based on grid squares and linked the practice to photography which by this time was "incessantly in use" in field archaeology.[107] His book included very similar advice on photography to that of Clements' *Research Methods*. Photographic methods were also central to two ambitious but uncompleted grid-based astronomical surveys launched in the late 1880s, the *Carte du Ciel* and the *Astrographic Catalogue*.[108]

The persistence of photographic methods in all these cases attests to the continuing importance of subjective visual judgement in science, even when in pursuit of quantitative measure. Clements said very little about how decisions should be made for locating quadrats within formations or stands of vegetation. Quadrats should be placed in "zones and societies of the same formation", he said, and in formations which show "marked zones and transitions".[109] But such formations and transitions must first be identified; they were readily recognizable because they were 'marked' at the scale of human vision. The quadrat itself could have no role in identifying and delineating the assumed plant communities in which sampling might take place. Prior expert judgement was required to recognize and discriminate between plant communities and, for Clements, this judgement was clearly visual and intuitive. Despite Tobey's grand claim, it was a matter of common visual sense, informed by appropriate field experience in vegetation survey. For just this reason, Henry Gleason had expressed his misgivings about the subjective basis for quadrat studies. Nevertheless, Gleason

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107 Petrie 1904: 5.

108 Kanas 2012: 337 *et seq;* Urban *et al* 1998. Ian Burney and Neil Pemberton (2013) have also noted this similarity between forensic and ecological methods and the broader tendency in contemporaneous field sciences for such regulated, systematic drawing practices, citing Gavin Lucas's history of archaeological methods (Lucas 2001) and Robert Kohler's account of Clements' quadrats (Kohler 2002a).

109 Clements 1905: 162, 167.

also believed that the quadrat method constituted "the only practicable means for the quantitative study of the association, and as such it forms an important adjunct to photography and verbal description."[110]

Moreover, when 'charting' a quadrat, as Clements called it, further visual judgment was required. "Each plant is put in whenever possible," he said, "but mats, turfs and mosses are merely outlined in mass if the individuals are not distinguishable."[111] The problems of 'charting' quickly become evident to anyone who has tried to map vegetation in this way. Vegetation is highly variable and often structurally complex; it is rarely so simply disposed that its constituent plants can be rendered as a series of simple lines and co-ordinates. Individual plants of different species differ markedly in form and growth, making assessments of relative cover problematic. Plants also share space, often arising from the ground in very close proximity. Aerial shoots cross and overlap, leaves and stems commonly stand over one another, even in the same plant, covering the same areas of soil below. Before the new quantitative method could be applied, the surveyor must not only recognise distinct plant communities, or identify and separate the different species present, he must also make detailed and difficult spatial assessments of the plants within the quadrat sample. These distinctions could only be made through visual assessment. As Robert Kohler put it: "Ecologists did not 'take leave of their senses' when they embraced the quadrat; they created a mixed practice that combined traditional field observation with quantification. Counting did not replace the senses but amplified them."[112] Indeed, both the theory and practical application of the quadrat method, and of field ecology in general, were centrally reliant upon visual — and specifically photographic — practices.

In *Research Methods*, Clements repeatedly emphasised the value to ecological study of photographic records in general, within a broader regime of technical instrumentation. "The camera is an indispensable instrument for the ecologist," he said "… it is as important for recording the structure of vegetation as the automatic instrument is for the study of the habitat. No ecologist is equipped for systematic field investigation until he is provided with a good camera and has become skilful in its use."[113] He stipulated the types of cameras and lenses that were most suitable for photographing vegetation. The camera should be of a size

[110] Gleason 1920: 21.
[111] Clements 1905: 169.
[112] Kohler 2002a: 107.
[113] Clements 1905: 188 *et seq*

to take plates at least 4x5 inches, always on a tripod, using swing movements and a lens capable of narrow apertures, to achieve sharp detail and great depth of field. He recommended specific camera models and lenses, as well as particular brands of photographic plates. He gave advice on obtaining the best exposure values for pictures in different types of vegetation, and suggestions for coping with windy conditions. He provided details for photographic procedure, and even offered guidance on developing photographic plates, and on suitable printing papers for making proofs that could be used in the field — though he recommended finished prints and lantern slides were best entrusted to a professional photographer. The purpose of all this guidance was to ensure pictures of a high quality; as far as possible they should also be aesthetically satisfying but, above all, they should provide clear and detailed description. "A fundamental rule of ecological photography," Clements wrote, "is that detail must receive the first emphasis. The ecological view should be a picture as well as a map, however; but when one must be sacrificed, artistic effect must yield to clearness, and accuracy, i.e., technically speaking, contrast must give way to detail."[114] Clements was not arguing for aesthetic pictures for their own sake. Rather, he was asserting the value of the aesthetic qualities of a picture — composition, contrast and so on — as aids to informed vision. When they are not allowed to overwhelm the photograph, these qualities contribute to its intelligibility and, therefore, to its value as a tool for observation and record.

Clements insisted, particularly, on the use of the camera in association with quadrats, to obtain appropriately-scaled photographs, encompassing the whole of a plot and rendering clear details of its vegetation content. Such was the value of the photograph, he even suggested that the size of the quadrat should be determined to suit its photographic record wherever possible. The photograph, he pointed out, was not merely an alternative visual record. "The chart and photograph serve as mutual checks, as well as complements, since the former shows number, position, and arrangement, and the latter, height, form, position, and arrangement."[115] Photographs yielded supplementary knowledge, different in kind from that which could be obtained by other means, through verbal description or even by other visual methods, such as charting, mapping or sketching.

Clements' methods for charting and photographing vegetation were quickly taken up elsewhere. Arthur Tansley for one believed they promised to become "an indispensable

[114] Ibid.: 191.
[115] Ibid.: 170.

means of investigating the phenomena of vegetation in adequate detail."[116] He also insisted on their educational value for encouraging good habits of looking, and skills in graphic representation. Drawing quadrat charts forced visual attention to detail, he said, just as drawing from microscopic observation forced attention to the detailed structure of tissues. "No one can become an expert in the finer structures of vegetation unless he has given them the same kind of attention, which is involved in the effort to represent them graphically."[117] In experimental work at Crockham Hill in Kent, Tansley was already applying quadrat recording methods in studies of heathland vegetation and succession in 1905. Charting the regeneration of heathland vegetation on land recently subject to mineral extraction, he recorded and photographed quadrats in the same locations, each year between 1905 and 1907. Photographic records survive from this work, as do their corresponding charts (Fig. 5.12). Tansley's field notes for the period also include written observations on species composition and subjective estimations of cover.[118] From the same years, the notebooks also include examples of sketches and data from larger quadrats applied to woodland vegetation in Surrey.[119]

As Clements suggested, Tansley here combined the two forms of graphical data — chart and photograph — as mutually supportive tools of scientific observation and inscription. By developing the quadrat method into a graphical tool for detailed mapping and monitoring, Clements returned plant ecology firmly to the realm of visual methods. The chart quadrat, referenced to its synchronous photograph, provided a visual register for the assessment and understanding of species composition, distribution and abundance. As another ecologist later put it, the value of the quadrat method "is that it presents to the eye at one time most of the facts as to the grouping of the plants within the small area mapped."[120] The chart replicated and interpreted graphically the pattern and complexity of vegetation that were evident to the eye; whilst the photograph provided indexical corroboration for the scientific observation of plant association and vegetation structure. In other words, the combined quadrat chart and photograph rendered relative abundance in spatial and visual terms that were analogous to visual experience in the field.

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[116] Tansley 1905.
[117] Tansley 1923: 120.
[118] The related records have become separated in the archive. The photographs are held by the BES as part of the Tansley Photographic Collection. TAN 3/26-28. 'Prints of Crockham Hill Common dating from 1905-07 (with negatives)'; the notebooks and quadrat charts are held with the Tansley Papers, at Cambridge University Library CUL/TP/B.4; B.84.
[119] Tansley Papers, Cambridge University Library CUL/TP/B.5
[120] Priestley 1913: 89.

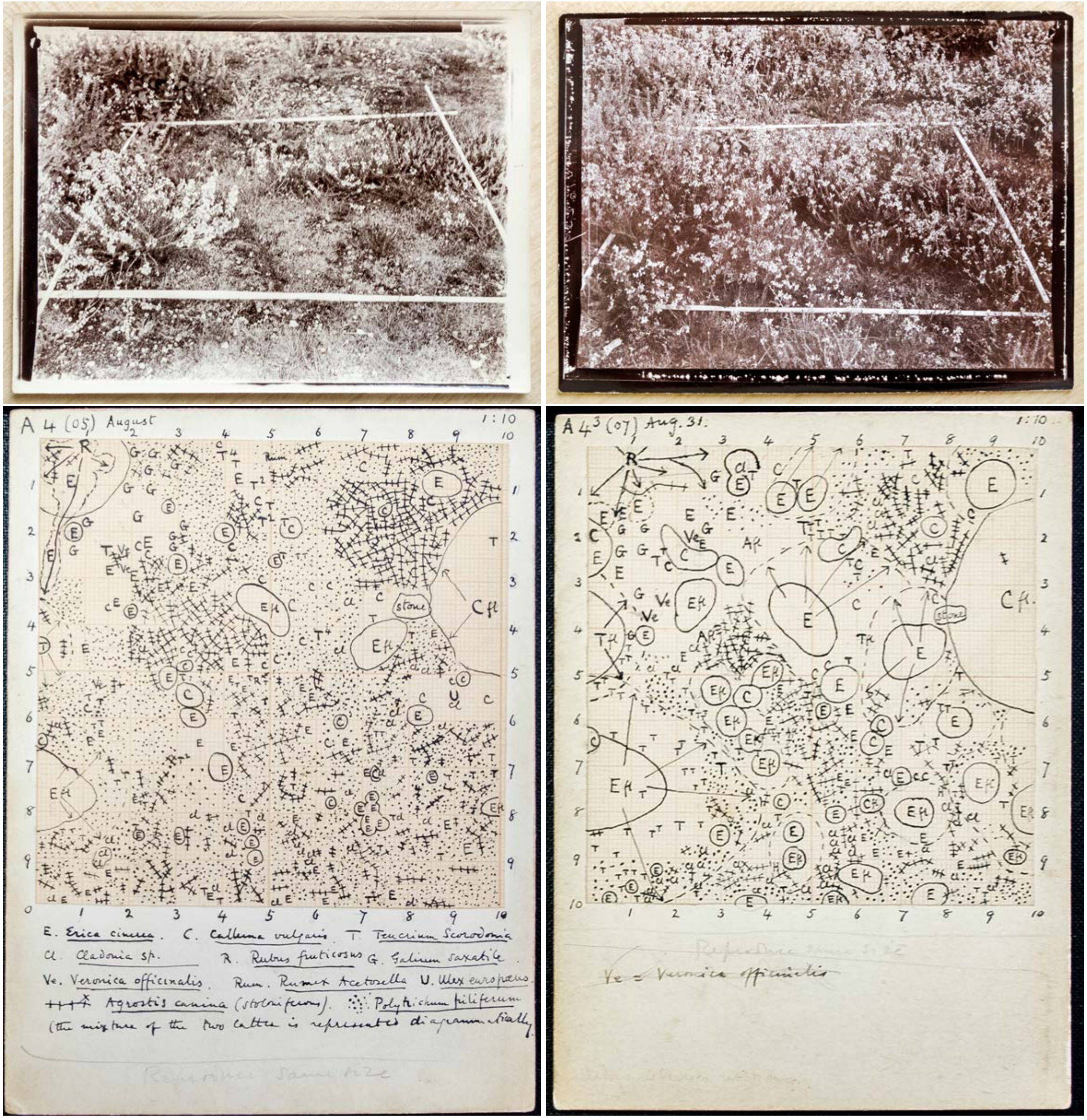

Fig. 5.12 *Arthur Tansley's chart quadrats and photographs from Crockham Common 1905 and 1907.* Photographs (BES Tansley Photographic Collection. TAN/3/26 & 28) and squared paper mounted onto card c.4½" x 6" (Tansley Papers, Cambridge University Library. CUL/TP/B.84)

The material form of these records further underlines the analogy of scientific record with sensory field experience and field method. The collection includes a second negative and print from the 1905 mentoring event, showing a slightly different view of the quadrat (Fig. 5.13). Of all the images Tansley made between 1905 and 1907, only this second 1905 print was ever reproduced for publication.[121] The reverse of the print carries pencilled annotations for reproduction and captioning and the image is cropped from the original plate to provide a finished print for use by the publisher's printer. The first 1905 print, and the 1907 print (Fig. 5.12, top left and right respectively) are contact prints. Photographers commonly made such contact prints to test the strength and quality of their negatives before for making finished prints. Clements' expected this to be the practice of ecologists too, not only to provide tests for printing but for their practical value in the field, noting that "It is the custom to make a proof of each negative to meet the casual needs that arise in the field."[122] The point here is that, in making contact prints, Tansley was making visual tools for practical ecological work in the field. At each year's monitoring, he would take with him into the field the prints from previous years, to make direct visual comparisons with the current state of the vegetation. This instrumental, practical field use of photographs is obscured in the finished, cropped prints of publications but becomes evident in working prints that survive in the archive, and reveals a field practice saturated with visual and bodily forms of knowing.

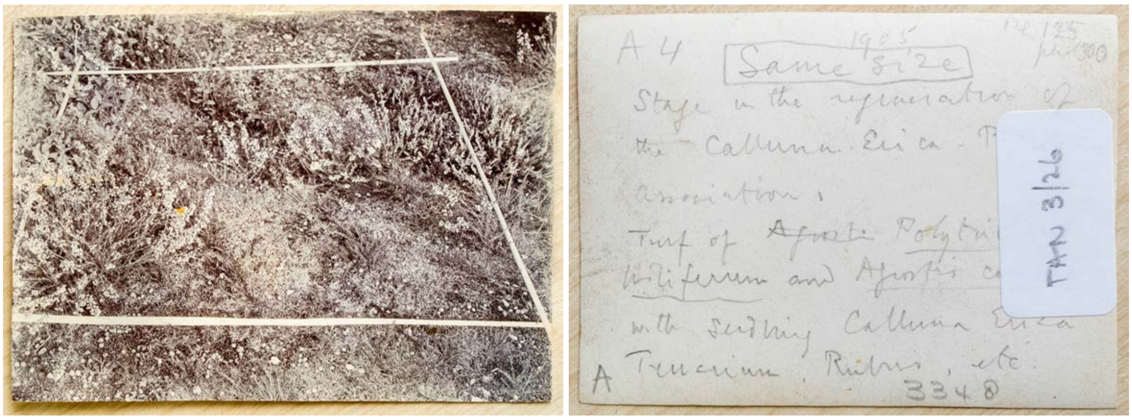

Fig. 5.13 *Arthur Tansley, quadrats photographs Plot A4, Crockham Common 1905.* BES Tansley Photographic Collection. TAN/3/26

[121] The image was reproduced in Tansley's summative work on British vegetation (Tansley 1939: 727, Plate 125/Phot. 307) and again in a shorter volume covering much of the same ground but addressed to a less specialist audience (Tansley 1949: 174, Phot. 80).
[122] Clements 1905: 195.

The quadrat charts too indicate this commingling of rational, quantified observation with embodied cognition in the field, and its erasure in the pages of published scientific accounts. The charts reproduced here at fig. 5.12 are drawn in ink. In both cases, an original pencil drawing has been largely erased, drawn over in ink to facilitate printing for Tansley's subsequent book on ecological methods, where they appeared in his description of the quadrat. Visible traces of the original pencil, remain, as barely discernible testament to Tansley's sketching hand in the field, standing over his quadrat square, carefully plotting his visual estimates for the lines of vegetation cover and the coordinates of individual plants. Moreover, in keeping with his general field-mapping practice, Tansley mounted his charts onto card, like his field maps, to address the practicalities of work in the field.[123] Like the contact-printed photographs, Tansley's charts would be available to take back into the field in subsequent monitoring years.

Like William Smith's pond drawings, chart quadrats were instruments of observation, tools for the production of ecological knowledge, obtained through looking, sketching and photographing *in place*. They confirm the embodied and sensory basis for ecological survey and mapping that we have already seen in Tansley's broader vegetation mapping practices (see *Mapping and the visual body*). Subjective vision remained at the core of vegetation science, even when ecologists sought hardest to find objective techniques for precise measurement and description. But none of this should be understood as a failure of objective scientific method. Ecologists did not see subjective visual methods as standing in contradiction to precise quantitative measurement. Visual methods, and their associated observational tools and practices, provided knowledge that was not inaccessible by other means. As Frederic Clements put it:

> Chart, map, and photograph are records indispensable to the systematic study of vegetation. They serve not merely to preserve the facts ascertained, and to permit their ready comparison, but they also put a premium upon accurate methods, and consequently bring to light many points otherwise overlooked. For ecology, they have the value which drawings possess in taxonomy, in that they make clear at a glance what pages of description fail to indicate. They are the fundamental material of comparative phytogeography, and in all careful vegetational study their use is no longer optional but obligatory.[124]

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[123] Tansley Papers, Cambridge University Library, CUL/TP/B.84; Tansley 1923: 112-113. Pencilled annotations on both the charts reproduced here provide instruction to the printer to "Reproduce same size." Other charts in the series were not used in publication and, although they too have been inked, they retain much more evidence of the original pencil markings. A diagram showing the method for mounting blank quadrat paper onto card appears in Tansley's book on methods, a few pages before his illustrations from Crockham (ibid.: 109).

[124] Clements 1905: 183.

Experiments in ecological surveying

Whilst Frederic Clements was attempting to lay out methodological guidance for American ecology, Frank Oliver and Arthur Tansley were also in search of quantitative methods for vegetation survey, in their ongoing field excursion programme for advanced botany students at UCL.[125] Following 1903's experimental surveys in the Norfolk Broads, a 1904 expedition was planned – in what was to be the first of several in successive years – to the Bouche d'Erquy on the northern coast of Brittany. The work at Erquy fulfilled Tansley's dual objectives for progressing ecological work, including both descriptive survey and more detailed analytical and quantitative studies. The latter aspects were directed to physiological questions of environmental adaptation, and to the measurement of habitat correlates for specific plant associations and community transitions. This analytical work included surveys of topographic levels, measurements of soil moisture and salinity, together with investigations of critical taxonomy and plant morphology, and was supported by appropriate instrumentation. From 1905 onwards, it was also facilitated by the acquisition of an empty cottage at the edge of the site, which was turned into a temporary but well-equipped lab for analytical work in soil and water chemistry and plant physiology (see chapter 4, Fig. 4.3).

But the primary work was surveying and mapping vegetation, to characterise its distinctive plant associations, their distribution and dynamic development. The work encompassed a number of methodological innovations for working at a detailed scale, adapted initially from elementary land-surveying techniques, and progressively refined as ecological field-mapping procedures. Adapting the surveyor's 'method of squares' and 'gridiron survey', the ecologists transcribed the different vegetation types, individual species and other physical features by eye, from a grid of squares marked out on the ground, onto squared paper. The so-called 'method of squares' was a relatively rapid procedure for dividing a large area of vegetation into a grid of 100ft squares. Working in groups of three, the students marked intervals of 10 or 20ft along the edges of each square, as reference points for sketching in physical features and the boundaries of different vegetation types onto scaled, squared paper. The resulting maps of squares were drawn at a scale of 1:240. The second method, the 'gridiron survey', was applied to areas of greater interest or complexity. This

[125] Tansley 1904b; Oliver and Tansley 1904. It is evident from a footnote to their account of the expedition, that Oliver and Tansley had already become aware of "the 'Quadrat method' used by the Nebraska School of Ecologists", and acknowledged some similarity with the latter's 'quadrat maps', but considered their own methods to be quite distinct. Clements' full account of the chart quadrat had yet to be published.

entailed more laborious procedures for the sub-division of the target vegetation into a grid of 5ft squares, a full 'gridiron' consisting of 25 such squares in a 5 x 5 grid. In both methods, the mapping was undertaken largely by eye but, at the larger scale of the gridiron (1:60), boundaries and transitions in character could drawn much more precisely (Fig. 5.14 overleaf). Ground levels and the precise location of particular features or plants could also be plotted, using a theodolite and levelling staff, with tapes to measure co-ordinates for transfer to the map. In both methods, the map would also be annotated with symbols to denote relevant information on dominant species and plant communities. Representative plant species would also be collected, labelled and pressed for later reference.[126]

Photographic recording was integral, at every stage in the refinement of these techniques. The painstaking work of vegetation mapping in the ‘gridiron’ was also supplemented by photographs of characteristic samples of vegetation. The importance of visual record was further underlined by the presence of two artists, who were charged with sketching in watercolour the characteristic saltmarsh landscapes. Clearly, drawing and sketching were also central to this kind of mapping work and recall again the tacit, embodied knowledge-making of quadrat-charting, and the pond-sketching practices of William Smith. Those practices were here refined and made more precise by the application of coordinated measurement and a cartographic grid, as guides to the sketching eye.[127] Nevertheless, the increased accuracy of these methods was no less reliant on subjective visual judgement. The location of the survey had been deliberately chosen for its topographic and botanical simplicity, where the vegetation was typically dominated by only a few plant species, separated into different communities by clear topographic divisions. This made it ideal for demonstrating the judgement required for such work, requiring only limited skills of species-identification and a general visual awareness to facilitate the mapping exercise. With practice, Tansley wrote, it was soon possible to estimate by eye the position of plants and vegetation lines, without the use of surveying equipment.[128]

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[126] Tansley 1904b. Tansley’s own perception of the novelty of the methods employed was indicated by brief anecdotal remarks concerning the perplexed response of local people. "The connexion of surveying and levelling instruments with Botany was, not unnaturally, far from obvious to their comprehension." Tansley’s account also records some potential conflict with French tourists, initially suspicious of the activities of these British visitors, as well as a playful (and acquisitive) “local peasantry and fisher-folk” who moved or stole their plot markers.

[127] Such grids were not the monopoly of scientific cartographers; it had been common practice since the renaissance for painters to use visual grids as guides for making accurate scale drawings. See, for example, Alpers 1983: 43; Edgerton 2009: 126-132.

[128] Oliver and Tansley 1904: 231.

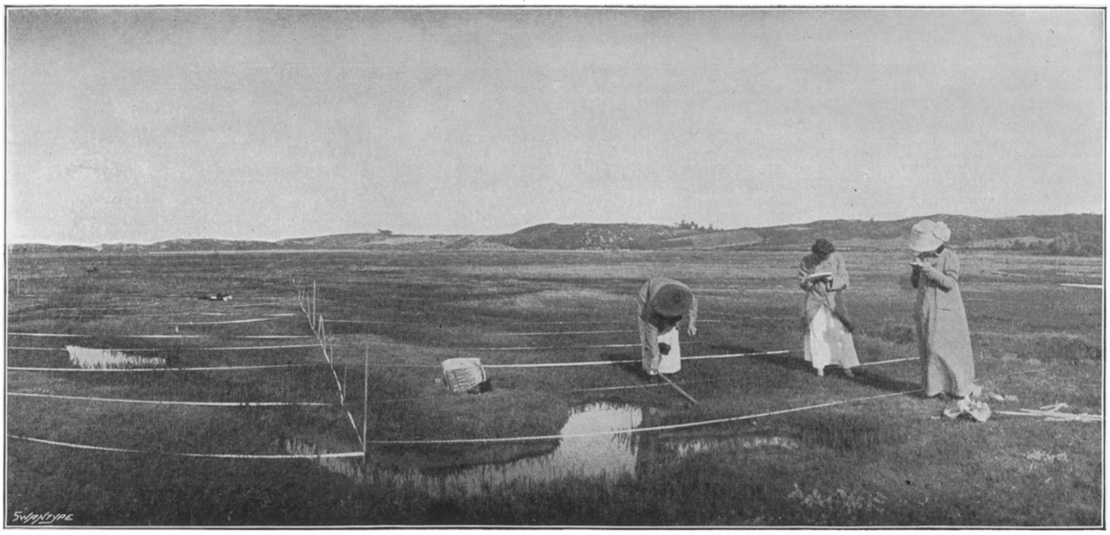

Fig. 5.14. Part of the Bouche d'Erquy, showing a gridiron survey under way in 1904.
From Oliver and Tansley 1904.

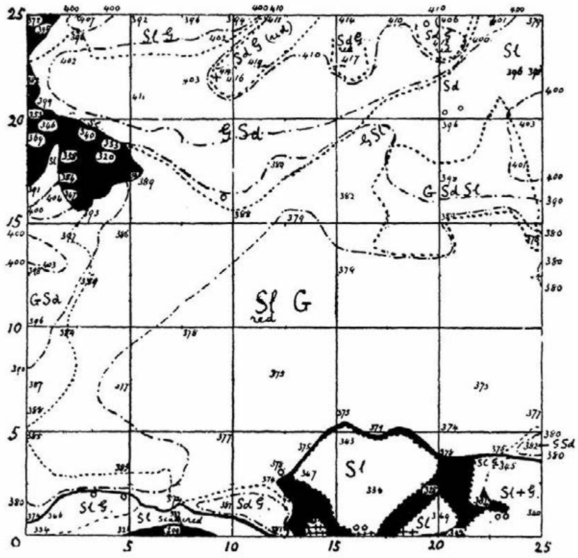

Fig. 80. A mapped Gridiron with levels and contour lines.
Two sets of " bars " at right angles to one another are represented.

Fig. 5.15. The same mapped 'gridiron' from the Bouche d'Erquy in 1904.
From Oliver and Tansley 1904.

In all such work, however, the identification and selection of typical or characteristic plant associations, their confident separation and delineation, required an experienced eye, even before the grid could be established; otherwise, how would one know where to place the grid, or draw a line on the map? Tansley's first brief account of the mapping process made this requirement for prior judgement clear. Whilst drawing the vegetation map, he said, "the physical features are put in first and then the boundaries of the different plant-associations, *those which are to be recognised having been previously agreed upon* and designated by symbols."[129] The judgement as to what constituted a recognisable vegetation community had to be made before mapping its distribution. In this case, where multiple surveyors were co-operating in the same exercise, it was first necessary to align the possible variations in their subjective judgements as to what might be seen and mapped. Recognition required training. Notably, whilst the general depiction of the local landscape was entrusted to artists, the task of photographing 'characteristic samples' of vegetation was undertaken neither by painters nor by student surveyors, but by experienced University staff. In this way, the 'agreed' vegetation types could be evidenced in future discussions, the photographs providing corroboration of the vegetation types that could be 'seen' in the field. Unlike Clements' quadrat, the methods developed by Oliver and Tansley at Erquy were designed to map more or less extensive areas of vegetation. The chart quadrat was intended to provide detailed information on the fine structure and species-composition of plant communities. But the similarity of the two approaches as visual methods is apparent. Both render subjective visual judgement as geometrically defined, mathematical space, whilst the resulting graphical representations are themselves visual, and are expected to retain a strong indexical relationship with their sensory originals. Like Clements' methods, the Erquy surveys were tied to other forms of visual representation, especially photography, and each of these visual tools was expected to provide collateral knowledge which would supplement and corroborate the survey's more 'scientific' findings.

The developing programme of fieldwork at Erquy continued to confirm this harnessing of visual judgment to analytical method. In April 1905, Tansley made an advance reconnaissance trip, walking over most of the study area, making notes, and taking photographs of the general landscape, the vegetation, and the grid-survey area. He had by this time become aware of Clements' newly published methods and, on the basis of what he saw in April, he

[129] Tansley 1904b: 202 (my emphasis).

decided to supplement the survey work with more detailed quadrat investigations.[130] The September expedition continued the extensive vegetation mapping programme, therefore, but with the addition of Clements' quadrat and transect methods for detailed botanical recording and mapping, applied to "a number of small typical areas in which the vegetation is *sensibly homogeneous*."[131] General mapping techniques and the new quantitative methods were intensively applied at the Bouche d'Erquy from 1905 onwards. Both relied on essentially visual procedures and issued in equally visual forms of data presentation. The fifty chart quadrats recorded in 1905 were supplemented by photographs of each of the vegetation samples, and others illustrating the general physiognomy of the vegetation, as well as watercolour drawings depicting the habit and form of typical plants. Tansley was confident that these methods provided "an exceedingly useful detailed record of the vegetation of the area."[132] They combined visual methods of mapping and picture-making with detailed quantitative records of plant species and physical habitat data, with the aim of achieving a comprehensive picture of vegetation that was at once analytical and synthetic. This was precisely the kind of investigative strategy that Humboldt had envisaged in support of his account of the vegetation of Mt. Chimborazo in the 1820s and reflected the same tripartite evidence base - map, image and physical description - that we have seen in use both by Humboldt and by the Smith brothers in their surveys of Scottish and Yorkshire vegetation between 1898 and 1903.[133]

Photographing vegetation and quadrat sampling quickly became established features of the work at Erquy but, in 1907, the general importance of photography was made still more apparent by the appointment of a "photographic specialist... able to devote his undivided energies to photographic studies on the marsh."[134] The cottage laboratory was fitted with a darkroom, producing over 100 negatives covering all the various aspects of research. Oliver's conviction in the value of photographic methods to ecological study was further demonstrated by the addition of a second specialist to undertake experiments in colour photography. The colour of the saltmarsh vegetation at Erquy had been a matter of particular interest from the beginning. "A very marked feature of the vegetation," Tansley wrote, "when it is at its highest point of development, in August and September, is the colour of the

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130 Tansley Papers, CUL/TP/B.4: "April 22. Erquy".
131 Tansley 1905: 192 (my emphasis).
132 Ibid.: 193.
133 See chapter 2 *New natural landscapes.*
134 Oliver 1907: 252.

Salicornia and *Suaeda*. These plants vary from bright green to deep crimson, according to their place of growth, and the landscape effects produced are of very striking beauty."[135] The same species here differed not only in shades of green but transformed starkly from green to red, depending on where they grew in the saltmarsh. Oliver and Tansley speculated that the plant coloration in these dominant species responded to variations in exposure to saltwater, resulting from varying durations of tidal inundation. Clearly, black and white photographs could not show the subtle but obvious differences in the appearance of the saltmarsh vegetation, and the absence of colour might mask underlying physiological or ecological factors.[136]

Unfortunately for Oliver, the long road to an easy photographic process capable of accurate (or at least naturalistic) colour reproduction was not quite complete in 1907. In 1903, the Lumière brothers had filed their first patent for the autochrome, the first really viable commercial colour photographic process. Oliver's first 'photographic specialist', Somerville Hastings, who had qualified in medicine at UCL, was both a keen botanist and an accomplished photographer. He subsequently did a great deal of autochrome work and published a number of popular botanical books, illustrated with both black and white photographs and colour reproductions from autochromes. In 1907, however, the Lumière process had barely come to fruition, with the plates only becoming commercially available that summer, and Hastings' work at Erquy does not appear to have included colour work.[137]

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[135] Tansley 1904b: 201. In his reconnaissance trip in April 1905, Tansley made extensive notes on the relative conditions across the marsh as the tide receded differentially from different parts of the saltmarsh, designating them as areas of 'applegreen' colour and the 'crimson plain'. (Tansley Papers, CUL/TP/B.4: "April 23. Easter Sunday")

[136] The difficulties of rendering shades of green in black and white photographs was well known, not only amongst ecologists, but also among landscape photographers. Contrasting reds and greens could also be problematic. To an extent, these difficulties could be could be alleviated by the use of coloured filters, to enhance the contrasts in tone between different kinds of vegetation. Hugh Hamshaw Thomas, a fellow Cambridge botanist and experienced photographer, who Tansley asked to write a few notes of guidance on photographing vegetation for his textbook on ecological methods in 1923, recommended the use of such filters for limited use in distinguishing vegetation structure (Tansley 1923: 207). The resulting tones and contrast were artefacts of the process, however, and for ecologists merely underlined the artificial rendering of colour in all black and white photography. Filters or screens for managing colour rendition and controlling contrast were known from at least the 1850s, and were more commonly in use by the 1880s in a range of photographic contexts (Photographic News 1888: 225-6). By the early 1900s, they were more or less readily available from photographic equipment manufacturers, such as Wratten and Wainright in London (Mees and Smith 1906).

[137] Oliver 1907. Dr. Somerville Hastings (1878-1967) was subsequently a Labour Member of Parliament and active campaigner for healthcare reform. He was awarded silver and gold medals for botany, as part of his medical studies at UCL. (Hastings 1907, Hastings 1908, Hastings 1910a, Hastings 1910b). Between 1911 and 1914, he exhibited both black and white photographs and autochrome pictures of

But Oliver was determined to address the question of colour photography, and had invited a second photographer to the 1907 expedition, specifically to conduct experimental work in colour. Kenneth Mees (1882-1960) had recently attained his doctorate at UCL, researching the physical chemistry of photographic processes. His doctoral research had just been published and, although only 25 years old, he was already a managing partner and research director for the photographic manufacturing company Wratten and Wainwright Ltd., where he developed the first commercial panchromatic photographic plates and a range of filters for colour correction. He subsequently went on to become the first director of research for Kodak. He was actively researching and publishing on the subject of colour photography in the years 1906-1909.[138] The nature and outcome of Mees' colour experiments at Erquy are unclear, since the resulting photographs have not survived. Nevertheless, the use of such experimental processes for recording and monitoring vegetation was highly innovative ecological work and makes it abundantly clear that the use of photography as an instrument of modern science was firmly embedded within the understanding of these early ecologists.[139]

In 1907 and 1908, the studies continued to intensify, with further physiological work, marsh vegetation studies and transplantation experiments, together with further innovations in visual method. The work of general vegetation mapping had been completed in 1906, but Frank Oliver now decided that maps of smaller areas should be re-recorded in greater detail,

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flowers and fungi at the Royal Photographic Society annual exhibitions, as individual exhibits and in lantern slide shows (erps.dmu.ac.uk/exhibitor_details.php?year=1912&efn=Somerville+Hastings [Accessed 26 March 2016]).

[138] Mees' doctoral research was published combination with his research partner (Sheppard and Mees 1907). For a brief biographical account of Mees research and career, see Clarke 1971. Mees' fuller account of *The Photography of Coloured Objects*, in 1909, dealt primarily with developments in colour filters for use in black and white photography, and was a blatently partisan account of the research and products emanating from his own company, Wratten and Wainwright Ltd. His highly theoretical treatment of colour photography *per se*, in one brief chapter, underlined the experimental nature of colour processes at this time, and his own position as a competitor to the already highly successful autochrome process. The Lumières' process received only brief mention at the end of a section on additive colour processes (Mees 1909: 63). In 1912, Mees became the first research director for Kodak, establishing its research laboratory in Rochester. Mees was also a member of his local camera club in Croydon, London, and a member of the Royal Photographic Society. Like Hastings, he too appeared at RPS annual exhibitions, in both pictorial and technical sections, as well as exhibiting apparatus on behalf of Wratten and Wainwright (erps.dmu.ac.uk/exhibitor_details.php?sn=Mees [Accessed 26 March 2016]).

[139] Hastings 1910b: v. In other contexts, the assumed representational veracity of the autochrome process was taken up for record photography, most notably from 1909 by the photographers commissioned by French financier Albert Khan (1860-1940) for his ambitious project to create a photographic archive of the whole planet (Les Archives de la planète). James Clerk Maxwell had first demonstrated his colour image of a tartan ribbon at the Royal Institution in 1861. See Cat 2013 for an interesting recent discussion of Maxwell's contribution to the development of colour photography and its surrounding discourses of automaticity and objectivity.

to monitor changes in the character and development of the vegetation. Photographic records were critical to his decision. The more detailed work in 1904 had included making photographic records for each of the sampled areas of vegetation, and for the general mapping survey. It was a simple conceptual step to regard the photographs themselves as a visual tool for monitoring change. Consequently, when he came to compare the mapping results from 1904 with the ground conditions in 1907, he relied on the evidence of photographs from the earlier survey. The dynamic character of the habitat, the patterns of colonization and vegetation succession, which could be difficult to discern in the quantitative data, and even in the general vegetation maps, were all clearly visible in the photographs. The photographs confirmed Oliver's visual impression of change. They simultaneously validated the findings of the earlier map and provided a direct comparison with the current state of the vegetation. It was this evidential aspect of the photographs that prompted Oliver to instigate more detailed mapping of a small section of the general survey area, to show the detailed patterns of plant-colonization across a sand-bank, in the bed of a broad channel crossing the saltmarsh (Fig. 5.16 overleaf). The same area was mapped in detail again in 1908, when one of Oliver's junior colleagues, Thomas Hill, wrote up the 1908 excursion, once again confirming the central role of photographic records for this kind of monitoring. "Photographs were taken in the autumn from many of the view-points of former years," he wrote, "so that there should be no break in the continuity of the records of changes in the vegetation."[140]

The Erquy studies demonstrate the importance of trained vision in work of this kind and the instrumental value of photographs to ecological methods in general. Photography's role in the general survey was more or less unproblematic; it was expected to provide straightforward description for the physical character of vegetation across the marsh as a whole, as well as within detailed sample plots. However, not all photographic records were so straightforwardly transparent and the repeat mapping project also reveals the limitations of photographic representation. In this flat coastal landscape, photography struggled to describe clearly the patterns of vegetation change so visible to Oliver's eye. None of the photographs were included in the expedition reports published in *New Phytologist* and they have not survived in the archive. However, a handful of Oliver's photographs from Erquy were reproduced 10 years later, in a study of coastal erosion management, together with two of the

[140] Hill 1909: 103. Thomas 'T.G.' Hill (1876-1954) was subsequently appointed to a lectureship under Oliver at UCL in 1912, ultimately succeeding Oliver as Professor in 1929.

many pictures taken by the 'photographic specialist' Somerville Hastings in 1907.[141] Two of Oliver's pictures, corresponding directly to the area of his chart illustrations, were reproduced in an extended and more technical account of saltmarsh vegetation development than those of the original *New Phytologist* reports (Fig. 5.17). The photographs require the careful scrutiny of an experienced ecological eye if they are to be understood as representations alongside the published charts.

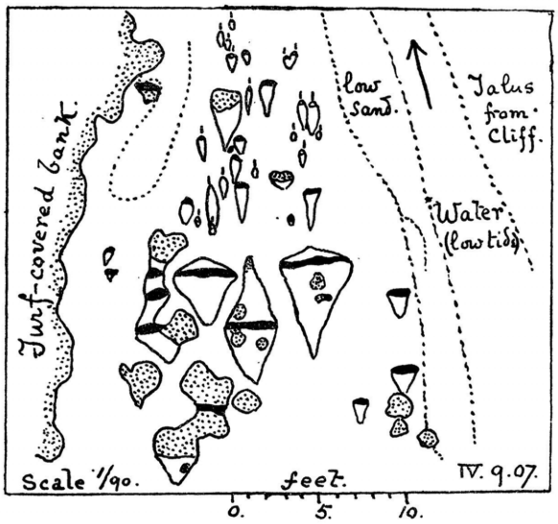

Fig. 4. Map (charted April, 1907) shewing colonisation of a sand-bank in the bed of a channel. The rhomboidal figures are the outlines of sand hummocks collected since 1903 by plants of *Salicornia radicans* and *S. herbacea*. The black transverse belts mark the *S. radicans*, whilst the position of *S herbacea* is marked by short vertical strokes. The hummocks accumulated by the latter are relatively small. The shading marks areas (hummocks) further colonised by *Glyceria maritima* and *Suæda maritima*. These two plants do not appear to settle directly on the sand-bank itself. The arrow points down stream. Scale $\frac{1}{90}$.

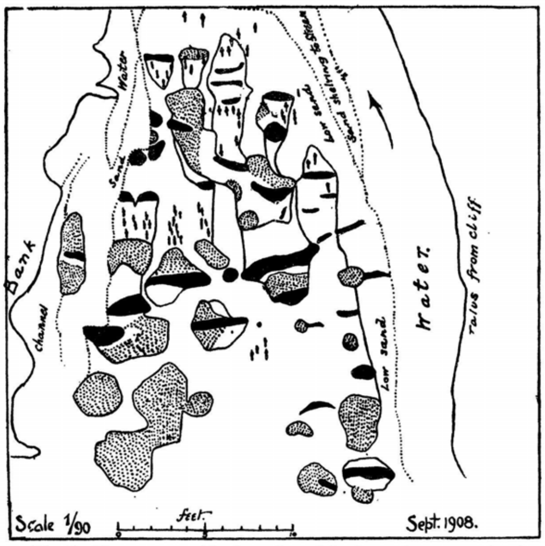

Fig. 5. The same sand-bank re-charted in September, 1908, shewing advance in colonisation. Explanation and scale as in Fig. 4. The greater breadth of the transverse belts of *S. radicans*, as compared with those in Fig. 4, is due to the difference in the seasons when the charts were made.

Fig. 5.16. Repeat vegetation mapping at the Bouche D'Erquy, 1907-08. From Hill 1909

Nevertheless, in their combination of vegetation mapping, photography and repeat observations, Oliver and Tansley had developed an innovative and systematic method for ecological monitoring. British and American ecologists in particular were acutely conscious of the dynamic character of vegetation and had developed a range of conceptual tools to describe change and development in plant communities, such as 'succession', 'zonation' 'migration' and 'ecesis'. Prior to the work at Erquy, no-one had sought to record such changes spatially and graphically. This was the first published instance of systematic, physiographic monitoring of vegetation character and development, and its visual presentation in the form of comparative charts. The visual foundation for ecological knowledge and representation, was here underwritten by photography, using a method of repeat photography now routinely understood and applied by ecologists as 'fixed-point photographic monitoring'.

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[141] Carey and Oliver 1918.

Plate XIX

Part of Bank charted in fig. 46 photographed three years before Chart 46A was made; it shows the earliest phase of colonization by *Salicornia radicans*, which in places has already orientated itself transversely to the current

Well-developed hummocks in phase 1 (cf. fig. 46A) with their belts of *S. radicans*. The white wisps consist of bleached Zostera leaves entangled from the drift

HUMMOCK DEVELOPMENT (BOUCHE D'ERQUY, BRITTANY)

Fig. 5.17. Francis Oliver. *Colonising sand-bank at the Bouche d'Erquy, in 1903 and 1907.* From Carey and Oliver 1918: Plate XIX.

Like the cartographic methods of Charles Flahault, Oscar Drude and Robert Smith, or Thomas Woodhead's efforts to map detailed vegetation communities against soil conditions, these experiments and innovations in ecological survey method were driven by visual experience and understanding of the vegetated landscape. Like the quadrat methods of Frederic Clements, on which this work sought to build, the experiments were intended to improve the quantitative precision of vegetation survey and mapping. Like the quadrat method, they were, nevertheless, reliant upon subjective visual judgement and the use of photographic recording. No less than William Smith's sketching, or Arthur Tansley's detailed studies of vegetation studies of woodlands and heaths, Frank Oliver and his students described what they saw more than what they counted. Using cameras and mapping techniques to provide evidence for plant communities and vegetation processes, their experiments also expressed the physical and cognitive disposition of the observing ecologist, negotiating the physical and affective landscape of 'the field'.

6. Taking to the Field: Exchanging objects/exchanging views

*My friend, you are not required to collect **anything**, but to observe **everything**.*[1]

The larger part of this thesis thus far has been devoted to demonstrating the profoundly visual basis of early ecological science, and the numerous uses to which photography was put by the first ecologists, in Britain and elsewhere. In previous chapters, we have seen that ecologists expected photographs to function as descriptive field notes, as evidence, as experimental and analytical method (chapter 5), as a facilitator for social and disciplinary cohesion (chapter 3), and as a strategy of education and communication, through related practices of display, exhibition and publication (chapters 3 and 4). All these took place, however, within broader social, institutional and cultural contexts, both in natural science and in the wider practices of photography. I have already explored some of ecology's disciplinary relationships with 19th century taxonomic botany. I have also explored some of the active social and institutional connections that ecologists maintained with amateur natural history. In this last chapter, I want to build on the insights of chapter 5, which foregrounded the visual and embodied experiences of ecological fieldwork, to reconnect ecology with some of the wider traditions and practices of field natural history. In doing so, I will first establish the parallel histories of practice in natural history and photography before returning to interrogate the common foundations for field experience and knowledge among naturalists, ecologists and photographers.

Notwithstanding its rapid professionalisation in the first decades of the 20th century, the relationship between ecology and natural history was every bit as foundational for the new discipline as any aspect of its relationship to 19th century academic biology. Ecology's departure from academic botany was premised on the importance of natural description and experimentation in the field, in partial opposition to the laboratory-based research that dominated morphological botany.[2] In important respects, ecology rose out of field natural history, under the transformative influence of Darwinian evolutionary theory, and it was 'in

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[1] Thornley 1903: 117-120.

[2] See Pickstone 2000 for a broader account of different 'ways of knowing' in science, which encompass both *descriptive* and *analytical*, as well as *experimental* modes. Pickstone, somewhat confusingly (given the long history of an identifiable tradition with the same name) refers to the descriptive mode as *natural history,* reflecting a broader purview current in the mediaeval culture of natural knowledge, taking in descriptive accounts and classifications of all kinds of the world's objects, not just the biological. Laboratory biology, in Pickstone's terms, was a typical 19th century *analytical* science.

the field' where ecologists met on common ground with naturalists, whose institutions and practitioners were overwhelmingly dominated by amateurs. Charles Elton, Britain's first prominent animal ecologist, was clear that "ecology is a new name for a very old subject. It simply means scientific natural history."[3] This strong connection was also indicated by the early description of ecology, most especially in the USA, as the 'new natural history'.[4] Just as photographic and other visual practices enabled us to interrogate the similarities and discontinuities between academic biology and ecology, and to understand the distinctiveness of ecological field methods, so the shared visual and material cultures of natural history, both old and 'new natural history', will enable us to trace a continuity in natural history, ecology and photography as field practices in the late 19th and early 20th centuries. In this chapter, then, I will consider the practices through which naturalists and naturalist-photographers facilitated a common understanding of their subject, in particular through society meetings and exhibitions and the collecting and exchange of specimens. I will then revisit the field excursion, to explore the communal and personal foundations for photographic and natural history practice, manifest in the performances of field natural history, in particular kinds of movement and observation, and their incorporation into material specimens, as scientific records and memorial inscriptions for the embodied experience of outdoor exploration.

The parallel practices of collecting and exchange in photography, ecology and natural history are particularly revealing in this respect. Through examples from the practices of Victorian and Edwardian natural history, photographic exchanges can be seen in the broader context of other material practices, in particular the collection and exchange of natural history specimens, both through physical exchange and in practices of display and publication. This exploration of the practices of collecting and exchange reveals linkages between objects, photographs and natural knowledge, and evinces a role for photographic practice and exchange in the structuring of common knowledge and experience in natural history, old and 'new'. Photographic exchanges in this context provided not only surrogate shared objects, but surrogates for the experiences and knowledge of naturalists themselves. This function is particularly apparent in accounts of the field practices of natural history, in which the physical performance of photography was embedded in practices of field-craft and observation. These

[3] Elton 1927: 1.

[4] Robert Kohler (2002a, ch.2) has reviewed the rise of the 'new natural history' in the USA in the first decade of the 20th century. The connection was revived again in Britain the 1940s, when Collins the publishers began a long-running series of ecologically informed books under the title of the *New Naturalist Library: A Survey of British Natural History* (Marren 1995).

accounts, published in journals addressing serious amateur and professional communities, were themselves a form of exchange which contributed to a personal and common sense of engagement with, and knowledge of, the natural world. Such accounts suggest an experiential function for photographic practice and exchange and the place of photography within a broader economy of knowledge, its material culture and social practices.

Exchanging photographs/exchanging objects

Well before the start of the 20th century, as Joan Schwartz has pointed out, "there was general consensus on the nature of the photograph as fact," of photographs as "records of simple truth and precision."[5] Photography "entered the nineteenth-century imagination", Schwartz suggests, "as a way of capturing the world in precise detail and bringing it home for careful study."[6] Schwartz, like others, places this culture of photographic collecting in a broader tradition, descending from the Wunderkammer of the late Renaissance, and the Cabinet of Curiosities, to the new museums of the 18th and 19th centuries, as part of a comprehensive project for harvesting and controlling knowledge of the world.[7] The 'cabinet of curiosities' is a well known trope — both in the history of science and, thanks to a number of key early examples, from the history of photography — and, in scientific photography, the use of photographs to describe natural objects or phenomena was already a central photographic interest from Henry Fox Talbot and Louis Daguerre onwards, both of whom depicted natural objects, singularly and in arrangements redolent of such 'cabinets'.[8] Indeed, natural subjects were common themes for early photographers, who made images of animals, both live and stuffed, seaweeds, plants, trees, rocks and fossils[9]. Such images reflected a more general,

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[5] Schwartz 2006: 74. Schwartz is here quoting Lady Elizabeth Eastlake, whose well known commentary on "Photography" appeared anonymously in *The Quartlerly Review* in 1857 (Eastlake, E. 1857. Photography. *The Quarterly Review*, 101**,** 442-468.)

[6] Ibid.: 66.

[7] It is a scholarly commonplace to regard such practices of collecting and display as expressions of regulated knowledge, developing in a tradition from the cabinet to the modern museum. See, for example, Impey and MacGregor 1985; Hooper-Greenhill 1992; Findlen 1994; Peter Bowler (1992: 251); Farber (2000: 13-14); Jan Golinski 2005: 95); and several authors collected by Bowler and Pickstone (2009). Daston and Park (1998) offer an alternative history, suggesting that neither the *Wunderkammer* nor early museums were conceived as truly inclusive and ordered encyclopædias of objects. Rather they were intended to display disparate marvels and curiosities, to encourage a sense of wonder and speculation, often ordered "against the grain of familiar classifications." From the 18th century onwards, however, naturalists in particular, began to make systematic collecting and taxonomic arrangement the organising principles for displays of natural objects.

[8] Other recent scholars also resort to the analogy between photographic records and objects arranged in cabinets of curiosities, for example Jennifer Tucker (2005: 21); Martha Langford (2001: 42)

[9] Seiberling and Bloore 1986: 60-62

Victorian culture of natural history interest. Daguerre's "Arrangement of Fossils" (Fig. 6.1 overleaf), with its obvious resemblance to a cabinet of natural curiosities, is a particularly well-known example, and when Talbot sent samples of his photogenic drawings to leading botanist William Jackson Hooker, as early as 1839, and again in 1859, he hoped that photographs might effectively 'stand in' for natural specimens, carrying the same values for identification and classification (Fig. 6.2).[10] Hooker was not convinced, but the exchanges are indicative of an assumption of equivalence between natural objects and their photographs, in the minds of photographic naturalists; an assumption that would only intensify as photographic techniques improved for reproducing naturalistic detail.

In addition to producing such photographic records of the objects of natural history, however, photographers also consciously emulated the practices of scientific and amateur natural history, in the widespread exchange and display of photographs between practitioners, and to a wider viewing public. Exchanging photographs was central to photographic practice, from the medium's very beginning. Formal Photographic Exchange Clubs arose as early as the 1840s and 1850s, and exhibitions quickly became a means of exchanging photographs with wider audiences. Photographic collecting and exchange have continued ever since in innumerable photographic clubs and societies. The history of such exchanges has generally been written as a discourse about *photographic* values, in which the concerns at stake were predominantly technical and aesthetic.[11] The exchange of prints or negatives between photographers, as photographers, perhaps inevitably places such medium-specific matters at the centre of concern. But as the technologies of photography stabilised, became more reliable and easier to use, photographic production expanded beyond the limited sphere of its early technical pioneers, and photographic exchange ceased to be primarily *about* photography or its qualities as a medium. Rather, such exchanges were made in support of any number of other instrumental and social purposes. In this context, it is

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[10] Sir William Jackson Hooker (1785-1865) was Professor of Botany at Glasgow University from 1820, and Director of the Royal Botanic Gardens, Kew from 1841 until his death in 1865. Talbot first sent a specimen of his photogenic drawings to Hooker in March 1839 (Hooker to Talbot, 20 Mar 1839, Talbot Correspondence Project no. 3842) and continued to promote photography as a means of botanical record and illustration for the next 20 years. In December 1847, Talbot sought to persuade Hooker of the value of making photographs of botanical specimens whilst travelling abroad (Talbot to Hooker, 21 Dec 1847, Talbot Correspondence Project no. 6064). Hooker was still unconvinced when Talbot sent him further examples in September 1859 (Hooker to Talbot, 11 Sep 1859, Talbot Correspondence Project no. 7954).

[11] Seiberling and Bloore 1986: 16

Fig. 6.1. Louis-Jacques-Mandé Daguerre. *Arrangement of Fossils (Coquillage), 1837-1839* (Daguerrotype)

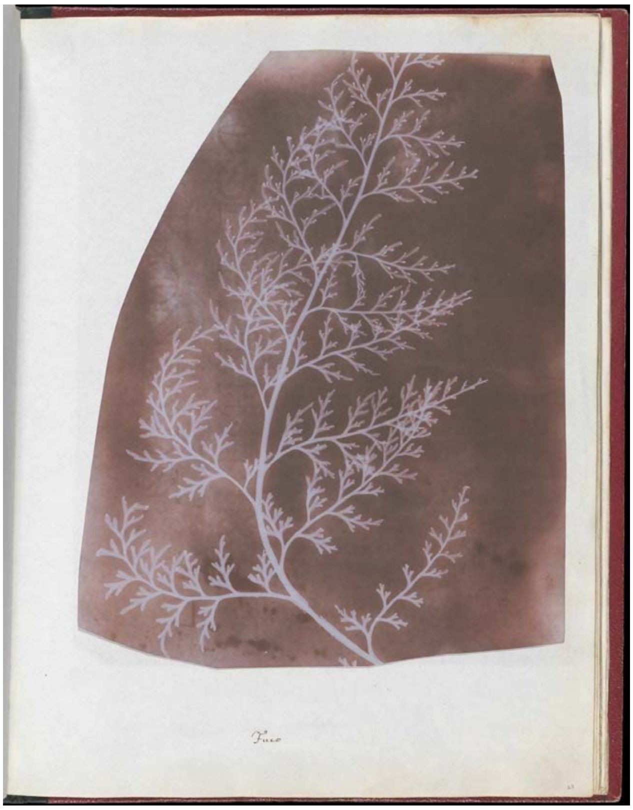

Fig. 6.2. William Henry Fox Talbot. *Wrack, 1839.* Metropolitan Museum of Art. 36.37 (25) (Photogenic drawing)

more appropriate to consider photographic exchange in relation to a broader culture of knowledge and *object*-exchange. This equation, and the conscious basis for photographic collecting and exchange, was explicit in a notice in the Photographic Society's Journal in April 1853, which strongly argued in favour of "a system of exchange of positives... similar to those which naturalists now experience from the interchange of local natural productions... once adopted, [the] *exchange of photographs will become as indispensable...as the exchange of plants is to botanists."*[12]

As "records of simple truth and precision,"[13] photographs and collected natural objects were epistemologically equivalent for the Victorian and Edwardian naturalist. Photographic collecting and exchanges replicated *object* exchanges, and shared their capacities for structuring and communicating knowledge and experience of the natural world. Ecologists shared the photographic and material practices of their more conventional naturalist colleagues and, through these practices in common, ecology and ecologists were implicated in the broader contexts of popular natural science. In the remaining sections of this chapter, therefore, I will explore these common practices, beginning with an overview of natural history collecting and knowledge exchange, in its wider context of a civic culture of science in late Victorian and Edwardian Britain, before returning to photography and field science. By investigating the photographic and scientific practices of ecologists and naturalists in the field, the chapter ties together the embodied methods of field practice explored in chapter 5, with the social and institutional connections between ecology and amateur natural history touched on in chapter 3.

Natural cultures of collecting

Collecting and exchanging natural objects epitomised the culture of 19th century natural history. For the 19th century naturalist, collecting was almost synonymous with the acquisition of knowledge. Botanical specimens, rocks, fossils, shells, birds (both stuffed and skinned) and their eggs, butterflies, beetles and any number of other insects, flowed freely between amateur naturalists, professionals and institutions. Through collecting and exchange, natural objects, collected in the field and assembled for viewing in cases and herbaria, became the *fabric* of natural knowledge; they were Latourian 'immutable mobiles', able to represent stable taxonomic orders wherever they were displayed.[14] The tradition of natural history collecting is most often examined through the practices of gentlemen

[12] *Journal of the Photographic Society* 1853: 10. The emphasis is in the original.
[13] Schwartz 2006.
[14] Latour 1990.

scientists and explorers, professional collectors and academic biologists.[15] But these kinds of study miss the vast bulk of naturalists' activity, undertaken by innumerable amateurs, engaged in private field-study and communal field-excursions, pursuing personal enthusiasms for understanding and engaging with the natural world.[16]

Anne Secord has observed that scientific culture in Victorian society was "widely equated with moral elevation and enhanced social status",[17] and much of the history of natural history has been written under the assumption that the social rewards of prestige and renown constituted central motivating factors for 19th century collecting practice. There is no doubt that such factors were manifest in the activities of many collectors. The prevalence of this kind of collecting, through which individuals might lay claim to respectability in scholarly circles, or in wider civil society, was such that, by the mid-century, it was possible for individuals to make a living by collecting material to supply to museums and wealthy collectors, some of whom would pay high prices for particularly prized specimens, or for whole collections.[18] Exotica were always highly prized by such 'cabinet-collectors', especially from tropical regions, and reflected a general Victorian fascination with the new horizons of Empire and travel opening up with overseas territorial expansion. This has given rise to the other central motif for historians of 19th century natural history collecting, especially as it relates to botany, of the heroic adventurer naturalist. Such professional collectors, of whom Alfred Russel Wallace (1823–1899), Henry Walter Bates (1825–1892), and Richard Spruce (1817–1893) are only the best known British examples, were engaged by museums and scientific sponsors (both private and institutional) to collect specimens from all over the world.[19] They operated in a context of active colonialism and imperial exploitation and,

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[15] Camerini 1996, 1997; Farber 2000; Browne 2001; Slotten 2004; Chambers 2007; Shermer 2002; Endersby 2008.

[16] David Allen's (1976) extended study of the history of naturalists in Britain, now 40 years old, is still exceptional in its comprehensive purview of natural history practice, encompassing professional, amateur and popular. Over the last few decades, popular science culture and its broader social context have presented active areas for the study of 19th century science, including natural history (for examples, see Jardine et al 1995; Lightman 1997, 2007; Secord 2000; Fyfe and Lightman 2007). Though much cited by others, however, only a few have followed Allen's example in the detailed examination of popular field practice in natural history. Partial studies along these lines have been undertaken by Lowe 1976; Secord 1994b; Watkins et al 2002; Phillips 2003; Withers and Finnegan 2003; and Finnegan 2005. More extended studies for particular geographic regions in Britain have been undertaken by Alberti 2000; Finnegan 2009; and Naylor 2010.

[17] Secord 1994b: 273.

[18] Allen 2009: 22.

[19] The figure of the explorer naturalist is so firmly established in popular understanding that the archives at Kew Botanic Gardens provide a research guide organised to help researchers find the 'Plant Hunters' they are looking for (Kew Gardens, Archives Research Guide: Sources for the History

whatever their scientific aspirations, together with their benefactors, they are rightly understood at least in part as economically motivated, both personally and politically.

Fig. 6.3. 'Capturing insects', from *The History of Insects, 1839.* Linnean Society of London. From Allen 1994.

There were also many socially-motivated collectors who were driven by a desire to build the biggest and best collections - for whatever subset of objects their curiosity alighted upon - and used such collections to indulge private interests and to cultivate a public persona with scientific credibility. For these collectors, commercial considerations were also prominent, encouraging a thriving trade in specimens as commodities first and scientific specimens only second. Some of these 'collection-builders' amassed great private collections and their

of Plant Hunters 18th to 20th Centuries.) Exotic collecting, especially in tropical regions, has continued more or less unabated since the 19th century. Susanne Renner (1993), for example, has catalogued a total of 205 botanical collectors, working in Amazonian Ecuador alone, between 1739 and 1988.

bequests have provided the foundations for many of the great museums of Europe and North America.[20] Lady Margaret Cavendish Bentinck (1715-1785) spent 50 years, and a substantial fortune, building an enormous natural history collection, for which she employed collectors all over Britain, as well as purchasing from collectors abroad; her collectors included Jean-Jacques Rousseau who credited her with his (perhaps limited) botanical education. Following her death in 1785, when her collections were finally broken up at auction, the sale took 38 days.[21] Sir Vauncey Harpur Crewe (1846-1924) is similarly noted for the huge natural history collections he amassed at Calke Abbey, especially stuffed birds, bird's eggs and Lepidoptera (butterflies and moths), but also many other stuffed animals, seashells, rocks, minerals, fossils, swords and memorabilia, including the skull of a crocodile, brought back from Egypt; many of them still on display in cabinets in the hall (Fig. 6.4). Sir Vauncey is remembered as something of a recluse, but with a private passion for the natural history of his local area, constantly out in the field in the company of his head gamekeeper Athagos Pegg.[22]

Fig. 6.4. Sir Vauncey Harpur-Crewe, Calke Abbey, National Trust.

But few collections were so extensive as these. The tendency to examine the practices of natural history collecting through the lens of professional collectors, gentlemen naturalists and socialites, misses the greater proportion of such collecting activity, which was undertaken

[20] Sir Hans Sloane (1660-1753) provides the best known example, whose huge collections formed the establishing basis for the British Museum.
[21] Allen 1976: 25; Farber 2000: 23.
[22] Salmon 2000: 183-184

by interested amateurs engaged in private field-study or communal field-excursions close to home. Most of these amateur collectors were more engaged with the actual field-practices of collecting than with amassing a huge private array of objects. Most of them were also more sociable than Sir Vauncey, many of them collecting as members of a natural history society or field club.

The development of structured arrangements for pursuing activities as disparate as literary study, astronomy, microscopy, rambling, cycling, natural history, photography, and even occult magical practices, is one of the most characteristic markers of Victorian and Edwardian society. Literary, scientific and philosophical societies were especially common, with at least one such society in most towns of any size. Natural history societies, especially field clubs, and photographic societies were also very common. The detailed history of field clubs and local natural history societies, which began to proliferate from the early 1830s, has been recounted elsewhere.[23] The activities of these clubs centred on communal field excursions for collecting, followed by indoor meetings for the exchange and exhibition of specimens, and to hear short presentations on subjects of natural history interest. Such practices mirrored those of professional and academic circles, whose Society meetings also included exhibitions of collected material, obtained on excursion by individual researchers in botany, zoology, geology, palaeontology etc. The predominance of amateur practice in the field is indicated, however, by the sheer number of naturalists' societies and field clubs established throughout the 19th century. In an 1873 survey conducted for the journal *Nature*, James Britten estimated that there were at least 169 local scientific societies in Great Britain and Ireland. 104 of these were field clubs. By the end of the century, the membership of natural history societies stood at almost 50,000, nearly half of the combined total for all the nation's scientific societies.[24] Most of these societies organised regular field excursions, in

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[23] See especially David Allen (1976), for a comprehensive history of naturalists in Britain and, more specifically, Allen (1986) on the history of the Botanical Society of the British Isles. See also Salmon (2000) for an account of entomological societies and collecting. Sam Alberti (2000) provides a valuable account of natural history societies in 19th century Yorkshire. Ann Secord (1994b) has also documented the activities of provincial botanists' informal association in the pub. Diarmid Finnegan (2009) has documented the natural history as civic science in Victorian Scotland, and Simon Naylor (2010) has documented the history of a Cornish society and its place in regional and national Victorian science.

[24] Britten 1873a, *Nature* 8: 521-522; 1873b, *Nature* 9: 99; BAAS 1905: 381; Allen 1976: 153. These are almost certainly under-estimates; they almost certainly omit many smaller clubs which were unaffiliated to larger society networks. Nor do they include field naturalists active in other scientific and philosophical societies, microscopical societies, archaeological societies, working-mens' clubs for botany and natural history, or the field outings organised by Mechanics Institutes or other educational institutions (Alberti 2000: 178). Lowe (1978), quoted by Alberti (2000: 179), estimated

which the collecting of specimens, physically and often photographically, dominated proceedings. The discursive and exhibitionary practices of Yorkshire naturalists, and those of the British ecologists, which we examined in chapter 3, were typical of such field societies.

Ecologists too, as we saw in chapter 3, 'collected' vegetation types or habitats in photographic form. Arthur Tansley, collected primarily with print publication in mind and most ecologists made use of photographs for public performance, in exhibitions, lantern shows and in print. But the traditional naturalists' urge to collect, as a means to complete knowledge, continued to be a prime motivating factor for some. Edward Salisbury, like Tansley, exchanged many of his photographs in publication. He also habitually used photographs in lectures and talks. Nevertheless, only a small fraction of his collection was ever used in this way. Salisbury stored his photographic plates in their original boxes, labelled and arranged by habitat, taxonomic grouping and geographical location. His individual plates carry handwritten markings, variably including species names, the date of taking, a habitat or geographical location, and a serial number. Otherwise, the collection appears to have been stored with almost no documentation. Whilst his photographic practice clearly related to his academic studies, it was also a semi-autonomous, personal project for building a systematic collection of photographs for British vegetation types and plant species and indicates a broader interest in comprehensive photographic collecting for its own sake.

Salisbury's collection was dwarfed, however, by that of Scottish botanist and photographer Robert Moyes Adam (1885-1967). A member of the Botanical Society of Edinburgh and its Alpine Botanical Club, and of the Edinburgh Field Naturalists' and Microscopical Association, Adam was a botany assistant at the Royal Botanic Garden in Edinburgh, where he worked chiefly as an illustrator, and where his duties included providing materials to support the lectures and publications of the Professor of Botany, Sir Isaac Bayley Balfour.[25] However, Moyes Adam was most energetic as a field photographer, ranging widely over the Scottish highlands and islands, photographing plants, vegetation, geological features and birds, as well as making very many landscape pictures, many subsequently reproduced in popular books and magazine articles celebrating the Scottish landscape. During these

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that there may have been as many as 100,000 field club members nationwide. Alberti lists an extraordinary 106 different naturalists' societies and field clubs active in Yorkshire between 1847 and 1905.

[25] Fletcher and Brown 1970: 233. See for example, papers by Isaac Bayley Balfour (1913a, 1913b) on the morphology of *Primula* species. Adam also took on the role of illustrator for the Botanical Society of Edinburgh and was secretary and treasurer for many years to the Alpine Botanical Club, a select group within the Botanical Society that met each year (almost every year of its 90 year lifespan) for a montane excursion to the Scottish highlands and elsewhere (Matthews 1968).

photographic excursions, often undertaken alone, or in the company of one or two close friends, he amassed a collection of over 14,000 images - almost entirely taken on half-plate and quarter-plate glass (Fig. 6.5).[26]

Unlike Salisbury, Adam made careful and meticulous records of all his photographs, initially on the negative envelopes and later transferred to registers, which he maintained from 1901 until 1956, when a heart attack put an end to his mountain excursions. His notes included species information, topographical particulars, dates, and information on printing for which, on occasion, he even sketched printing exposure details to guide his subsequent practice in the darkroom.[27] Although his photographs were widely used by other botanists, travel writers and journalists, however, Adam published very few of his own pictures and clearly did not make them primarily for such purposes. It seems, like Salisbury, he collected views and photographic specimens, of scenery, plants and animals, for their own sake.[28] Nor did he publish much on matters botanical, or other aspects of the natural history observation that so long dominated his working and private lives. He left no memoir to assist in understanding his motivations for this photographic practice.[29] It is clear from the work itself, however, and from his precise documentation, that he prized both the photographic and scientific values of the records he made. He was motivated by a desire to collect specimens of the natural biological wealth of the Scottish landscape, making the clearest and most accurate records he knew how, of the animals, plants, and habitats he found there. That he was driven to do so predominantly through photography is especially significant.

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[26] Matthews 1968. Adam's collection was acquired in 1958 by the *Scots Magazine,* when it was estimated to include about 15,000 plates and 60,000 prints.

[27] Jackson 1998. Adam's registers and negative envelopes still survive and are held at St. Andrews University Library, which acquired the collection in 1987.

[28] Regular publication of his photographs in the *Scots Magazine*, between 1944 and 1947, and in other magazines, made Adam a household name in Scotland (Matthews 1968). From the 1930s, topographical writers in particular began to seek out Adam's photographs; botanists and ecologists concerned with the Scottish flora and landscape began to use his pictures after they became more widely known. (Jackson 1998; Padget 2010: 157). Nevertheless, Adam's published photographs were limited to occasional plates illustrating papers by others, in particular in the transactions of the Botanical Society of Edinburgh, and in his own contributions as secretary of the Alpine Botanical Club. He published only one book of his photographs (Adam 1948).

[29] But see Adam's interview with Jeremy Bruce-Watt from 1958 (Bruce-Watt and Adam 1958, *Photographer of the Hightops*)

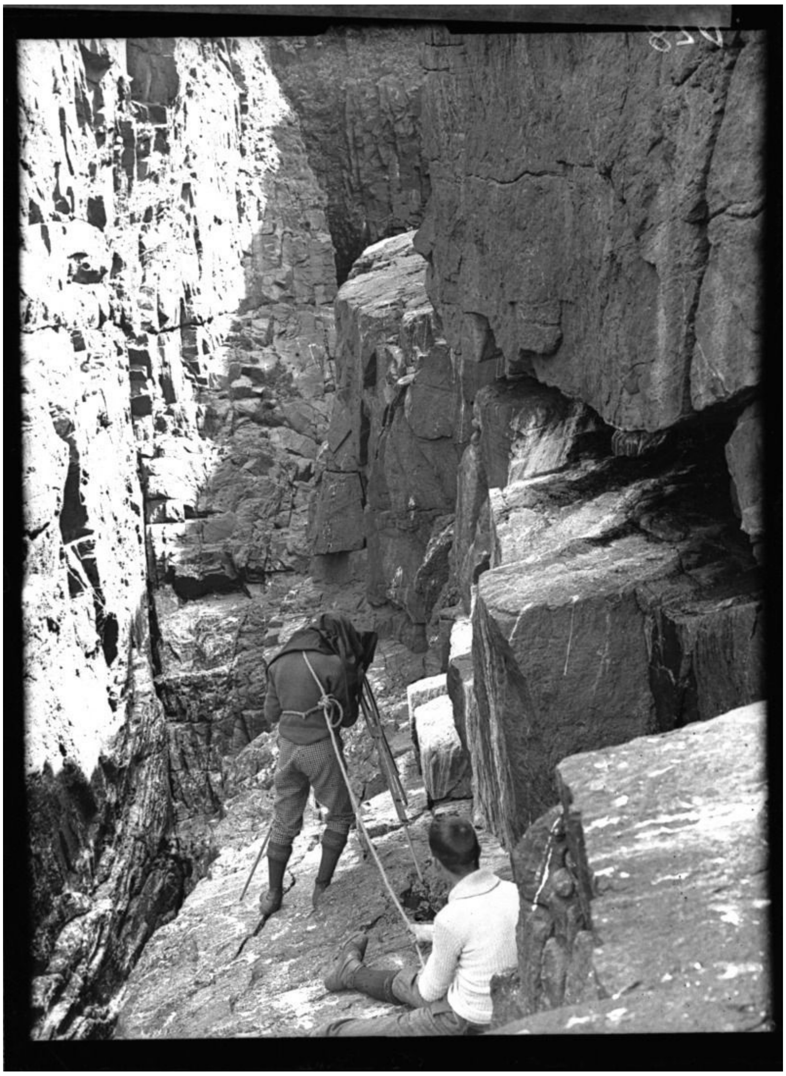

Fig. 6.5. R.M. Adam, *Photographing Shags, 1905.* Robert Moyes Adam Photographic Collection, University of St. Andrews, RMA-S.87A.

Photography for Adam was both a technology of record and a means of aesthetic appreciation but, equally importantly, photography was a field practice which mirrored that of the naturalist. Its use signalled a complex entwined concern to record his own experience of moving, observing and photographing in the places of natural history, alongside both mechanical record and aesthetic inscription. It is this embeddedness in the places of his observation and experience that gives the photographs of Robert Moyes Adam the qualities for which they have since become acclaimed as celebrations of the Scottish landscape and its ecology.

Talking, showing, publishing

I have already noted in passing the practices of collecting and exchange amongst 19th century photographers. Histories and details of such practices have been written by others, for both general and particular contexts, requiring only brief summary remarks here to establish the common practices and shared by photographers, naturalists and ecologists all alike. Photographers established select organisations for collecting and the mutual exchange of photographic prints as early as 1841, only two years after photography's first public announcement.[30] The Photographic Society was established in London in 1853 with the exchange of prints as one of its was central activities. Other photographic clubs arose rapidly across Britain in the 1850s.[31] Like the naturalists societies, the formation of new photographic societies exploded in the last third of the century. In Yorkshire, for example, in 1891, there were at least 18 active photographic societies.[32] Nationally, both the number of societies and their overall membership increased rapidly towards the century's end and, by 1914, somewhere between 10,000 and 20,000 amateur photographers were supporting around 350 separate photographic clubs and societies.[33] Like their naturalist counterparts, the new photographic societies were dedicated to the exchange of pictures and expertise, and to the development of communal photographic practices, in meetings and various forms of exhibition and, subsequently, in joint photographic excursions.[34]

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[30] The earliest such societies were exclusive gatherings of 'gentlemen amateurs', the first in Edinburgh in 1841, with the Photographic Club or Calotype Society following in 1847. For the general context of exchanges, and the early development of photographic societies and dedicated exchange clubs in the mid-century, see especially Seiberling and Bloore 1986; and Taylor 2007.

[31] The Photographic Society encompassed the more exclusive grouping of the Photographic Society Club (sometimes also called the Photographic Club); the Photographic Exchange Club followed in 1854, and the Amateur Photographic Association, in 1859. A photographic society had already been established in Leeds in 1852, Liverpool followed in 1853, along with Dundee (1854), Glasgow (1854), Dublin (1854), Manchester (1855), Edinburgh (1856), Birmingham (1856) and many other provincial and rural towns. Jens Jäger has listed 35 new photographic societies founded between 1852 and 1861 (quoted by Roger Taylor (2004: 259 n.32; 2007: 60). Similar beginnings were also made in photographic associations elsewhere in Europe and America; these included Societé Heliographique in France (1851) and its quick successor the Societé Française de Photographie in Paris (1853); the United States' first examples were the American Photographic Society (1859), and the Photographic Society of Philadelphia (1862) (Simmons 2008: 31-35)

[32] The number of Yorkshire photographic societies here is taken from the *First Report of the Geological Photographic Committee of the Yorkshire Naturalists' Union* by James Bedford (1891: 69).

[33] Pritchard 2012. These figures do not include postal groups, nor do the estimates of numbers include professional photographers, casual amateurs or 'snapshotters' (as Pritchard calls them) which, by this time were numbered in millions. By the end of the 1890s, the British Journal of Photography Photographic Almanac listed over 250 photographic societies and clubs in Britain (BJP Almanac 1898: 574-608).

[34] Displays of photography in the celebrated, mid-century international exhibitions - the Great Exhibition of 1851, and the Great International Exhibition of 1862 - were merely the most prominent

Photographers received regular news of exhibitions from other societies, at home and abroad, in the photographic press.[35] These were specifically photographic exhibitions, but photography was also prominently on display in many other institutional and disciplinary contexts, where its descriptive and record capacities were deployed in support of other activities. At the Great Exhibition of 1851, for example, most photographs were displayed a range of technical or industrial sections, rather than as in photographic exhibitions in their own right.[36] By the end of the century, photographs were regularly on display at meetings of the British Association for the Advancement of Science, the Royal Society, the Society of Arts, Mechanics Institutes, university and college lecture halls, and at meetings of local scientific and natural history societies.[37] In these contexts, photographic exchanges were rarely primarily concerned with specifically photographic or pictorial practice; rather they reflected the many other interests pursued by photographers, and by others using photography. Among photographers, other enthusiasms included antiquarian subjects especially, but also a wide range of other objects and phenomena in natural science.[38] Elizabeth Edwards has

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examples of what became a commonplace practice amongst photographers, amateur and professional alike, by the end of the century. Following its founding in 1853, the Photographic Society (subsequently the Royal Photographic Society) held annual exhibitions from 1854. Many of the new societies were dedicated to photographic exhibitions, with early shows in Edinburgh, then Manchester, Norwich, Birmingham, Glasgow and increasingly elsewhere. Steve Edwards (1996, 2006) has provided exhaustive accounts of the role of photography in the two Great Exhibitions; Seiberling and Bloore (1986) discuss in some detail the regular exhibitions held by the Photographic Society in the 1850s. A comprehensive listing of 48 *Photographic Exhibitions in Britain 1839-1865,* and their exhibits, can be found in an online database, hosted by De Montfort University at http://peib.dmu.ac.uk. Similarly, catalogue records for over 45,000 exhibits shown in the annual *Exhibitions of the Royal Photographic Society 1870-1915,* are provided in a searchable database, together with digitized images of catalogue pages and some of the photographs displayed, at http://erps.dmu.ac.uk.

[35] In 1896, for example, the BJP carried notices of fifteen separate exhibition in that year, including the usual Royal Photographic Society annual exhibition, the London Photographic Salon and others from Beverley to Bristol and from Cardiff to Hackney. It also included details of an exhibition at the Musée Moderne in Brussels, organised by the Belgian Photographic Association and showing a selection of 500 pictures from 2300 submissions, from 225 photographers in eleven countries. (BJP 1896: 249-50). The numbers of exhibitions inevitably varied from year to year, with notices for 16 in 1889, 30 in 1893 and 40 in 1911, but the BJP notices almost certainly covered only a small proportion of the smaller provincial society exhibitions.

[36] Edwards 1996, 2006.

[37] Edwards 2008: 1305

[38] Seiberling and Bloore 1986: 47. As early as 1864, Dr. Hugh Diamond observed that there was 'scarce a branch of art, of science, of economics, or indeed of human interest in its widest application, in which the applications of this art have not been made useful.' He listed professions using photography, including medicine, law, architecture and engineering, manufacturers, ethnology, natural history, archaeology and antiquarian pursuits (Diamond 1863: 339–46). In 1889, laying the ground for his argument on the value of photography as a naturalistic art, Peter Henry Emerson reviewed some of the accomplishments of the 'cool young goddess' photography. He divided photographic work into 3

described some of the specific contexts of photographic exchange for the latter part of the century, first amongst anthropologists and, more recently, amongst photographers engaged in the British photographic survey movement spanning the turn into the 20th century.[39] "It is quite clear to anyone with a comparative knowledge of photograph collections", she wrote in 2001, "that the flow of images between scholars and other interested parties, in the nineteenth and early twentieth centuries, was constant and significant."[40]

The photographic survey movement was the most prominent photographic collecting enterprise of the late Victorian and Edwardian period. Its photographic concerns entwined scientific and aesthetic aspirations with a desire to record the material evidence of the past. Their antiquarian and architectural subject matters were already centrally located in the pictorial practices of photography and a wider, 'historicised' visual culture of the picturesque, and they were keen to promote this blend of pictorial and documentary interests in exhibitions.[41] The movement was also dedicated to the construction of a pictorial archive, however, and its photographic collecting of antiquities and views provides a direct analogue for the collecting and exchange activities of naturalists, who collected specimens — fossils, rocks, moths or flowering plants — as representatives of natural object categories. As Seiberling and Bloore have pointed out, naturalists and photographers alike "referred to the objects they collected as 'specimens', and for both groups of enthusiasts the amassing of collections was an activity of interest in itself."[42] A number of photographic surveys were in fact instigated by natural history societies and, in such cases, naturalists and photographers coincided in the same societies, and often in the same person, making the analogue between photographs and specimens still clearer and closer. Elizabeth Edwards tells us, for example,

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divisions - Art; Science; and Industry. Whilst art appeared to be a self-contained category, under science he listed numerous sub-divisions and the Industrial encompassed the vast remainder of the photographic world - including technical and commercial photographers, "who will take anyone or anything if paid to do so," from statuary to landscapes, 'bits' of scenery, and animals, from 'magic cigar photographs' to photographs on porcelain. (Emerson 1889: 11-12).

39 Edwards 2012a.

40 Edwards 2001: 27.

41 Edwards 2009; Edwards 2012a: 6-8. Edwards has also observed that the survey movement shared many of its photographic values - truth to nature, observational accuracy and print quality - with certain strands of pictorialism that were especially prominent in the 1890s and 1900s (ibid.: 85-6). She also provides numerous examples of exhibitions dedicated wholly or partly to survey photography, including regular exhibitions by the Warwickshire Survey in Birmingham from 1892, in Nottinghamshire in 1897, Norwich Norfolk in 1913, exhibitions of survey groups in Surrey, Sussex and Kent, and major exhibitions at Crystal Palace and the South Kensington Museum (now the Victoria and Albert Museum), among many others. Individual survey photographers also contributed to major national and international exhibitions. (ibid.: 40; 92; 94; 230 *et seq*).

42 Seiberling and Bloore 1986: 61

that Alice Geldart served on the committees of both the Norfolk photographic survey and of the Norwich and Norfolk Naturalists Society, whilst Surrey photographer Drs. J.H. Baldock and J. Hobson, were members both of the Surrey photographic survey society and the Croydon Natural History and Microscopical Society.[43] Godfrey Bingley, a member of the Leeds Photographic Society, was a prime mover for the photographic survey movement in Yorkshire, and also contributed survey photographs elsewhere. He was also a member of the Geological Society, Leeds Natural History Society and the Yorkshire Naturalists' Union, and from 1900 sat on a Committee for the Collection of Photographs of Geological Interest, instigated by the BAAS.[44] Alfred Clarke and Charles Crossland, both expert mycologists and productive photographers, pursued their interests jointly, as members of the Huddersfield Naturalists' and Photographic Society and the Halifax Naturalists' Society respectively, and in the Yorkshire Naturalists Union.[45] Naturalist photographers satisfied their impulse for collecting through both activities.

Natural history had been a manifest photographic subject for the earliest British photographers, including many members of the Photographic Exchange Club established in 1854, whose exchanges included landscapes, plants, animals and still life, and natural history has remained a persistent theme for many photographers ever since.[46] For much of the century, submissions to the annual exhibition of the Royal Photographic Society had been overwhelmingly pictorial, with natural history represented through a smattering of highly conventionalised flower studies, photomicrographs and, implicitly, in many landscape views. Scientific and technical images also began to appear, however, and by 1900, pressure to incorporate other kinds of photographs resulted in a separate section for 'Scientific, Technical and Photomechanical Exhibits', which encompassed technical prints, astronomical photographs, photomicrographs and a number of natural history subjects.[47] For a brief moment, in 1910 and 1911, natural history was afforded its own section. By 1920, natural

[43] Edwards 2012a: 45, 88, 103. Edwards lists 8 surveys instigated by natural history related societies. Four of these were combined natural history and archaeological or antiquarian societies (Dorchester, Hertfordshire, Somerset and Wiltshire), Huddersfield was a combined natural history and photographic society; Chester and Northamptonshire were solely dedicated to natural history, whilst Essex was a field club. (ibid.: 263-266)

[44] Bedford 1891*:* 69 *et seq.*

[45] YNU Annual Report 1896: 24-25; Charlesworth and Ellis 1968: 28

[46] Seiberling and Bloore 1986: 60-62; 134. For some, such as George Shadbolt and John Dillwyn Llewelyn, natural history and its related pursuits (for Shadbolt, especially microscopy) held a particular interest.

[47] Early scientific images were often exemplars of new photographic processes, such as platinotypes, first shown in 1879, and x-ray photography in the late 1890s, but also soon included photographs made in the course of other scientific work.

history pictures were very prominent in the technical section and, from 1922, the scientific and technical section was sub-divided, with natural history once again a separate category.[48] Natural history and technical images of various kinds doubtless also found their way in small numbers into the displays of local photographic societies throughout this period. On the whole, however, natural history photographs were less visible than those of either pictorial or survey photographers. Whilst public performance, in exhibitions, lantern shows and in print may have been primary aims for survey photographers, most naturalists and ecologists were concerned with the less public forms of exchange, within scientific societies, during excursions and meetings or in specialist print publications.

Nevertheless, the practices of collecting and exchange in photography closely mirrored those of the more seasoned naturalist collectors and, by extension, those of ecologists who, as we saw in chapter 3, shared a visual and material culture with natural history, moving freely between their own societies and those of other naturalists. Those similarities had long been embedded in the social and civic infrastructure of Victorian science, in which the pursuit of knowledge was morally validated by the interchange of experience and skill with one's fellow citizens. As we have seen, the proliferation of field clubs, naturalists societies and photographic societies was especially marked towards the end of the 19th century and this growth was centrally predicated upon notions of civic participation, and sharing of the rewards which flowed from common endeavour. Among naturalists, this ethical and communitarian basis for practice gave rise to a moral ideal of the experienced naturalist pedagogue, around which the model of social and scientific exchange coalesced into formal associations and societies. Ann Secord's account of Lancashire botanists meeting in the pub to examine specimens and share scientific natural history knowledge has brought the social practices of Victorian natural history to life for many readers,[49] but every branch of natural history had its exemplars for this moral ideal. In 1856, for example, in *The Entomologists'*

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[48] The subdivisions varied slightly but were listed in 1925 in the following way: A. Natural history; B. Photomicrographs; C. Radiographs; D. Astronomical, Aerial and Spectrum photographs; E. Stereoscopic work; F. Scientific colour work; G. Technical applications of photography; K. Kinematography. Illustrated Catalogues appeared for the Annual Exhibitions of the Royal Photographic Society, appeared in the Society's *Photographic Journal.* The journal volumes from 1853-2012,are available online from the Royal Photographic Society at www.rps.org/journal-archive. Digitised catalogues for the RPS Annual Exhibitions between 1870-1915 are also available at http://erps.dmu.ac.uk [Accessed 15 June 2016].

[49] Secord 1994a, 1994b. Other naturalists' societies, especially field clubs, shared similar origins and practices, and many drew membership principally from workers and tradesmen of modest means. The Huddersfield Naturalists' Society had its first origins in a meeting in the pub, although it moved quickly into a schoolroom for subsequent meetings. (First Minute of the Huddersfield Naturalists' Society, reproduced in Charlesworth and Ellis 1968.) See also Salmon 2000 on the early history of entomological societies in Britain.

Weekly Intelligencer, Henry Stainton advertised himself 'at home' on Wednesday evenings to any interested visitors "(whether previously known to him or not), who may wish to look at his collection or consult him on any entomological matter."[50] His advertisement even included helpful information on suitable train times. Similarly, from at least the 1850s, Huddersfield naturalists James Varley and James Mosley made their collections available to others.[51] Varley also made his extensive collections of birds, eggs and Lepidoptera available for display in local exhibitions. There was doubtless some social caché attached to this role of expert consultant, but the sharing of knowledge through collections was also an indication of the personal qualities prized in the expert amateur naturalist - good humour, generosity of time and knowledge, and hard work. Above all, the expert collector should be actively amenable to sharing the rewards of collecting, granting personal access for others to the objects in the collection, sharing the knowledge and expertise obtained through field collecting and associated natural history study, and making a marked contribution to the collective work of natural history in general.[52] This ideal of the naturalist was persistent well beyond the end of the nineteenth century, not only in amateur circles but also amongst the rising professional circles of the 'new natural history' of ecology. These social and expert qualities were the foundation for a wider community of knowledge among naturalists, in which objects and expertise were circulated, cementing civic ties and promoting the collective values of skilled knowledge and experience of the field.

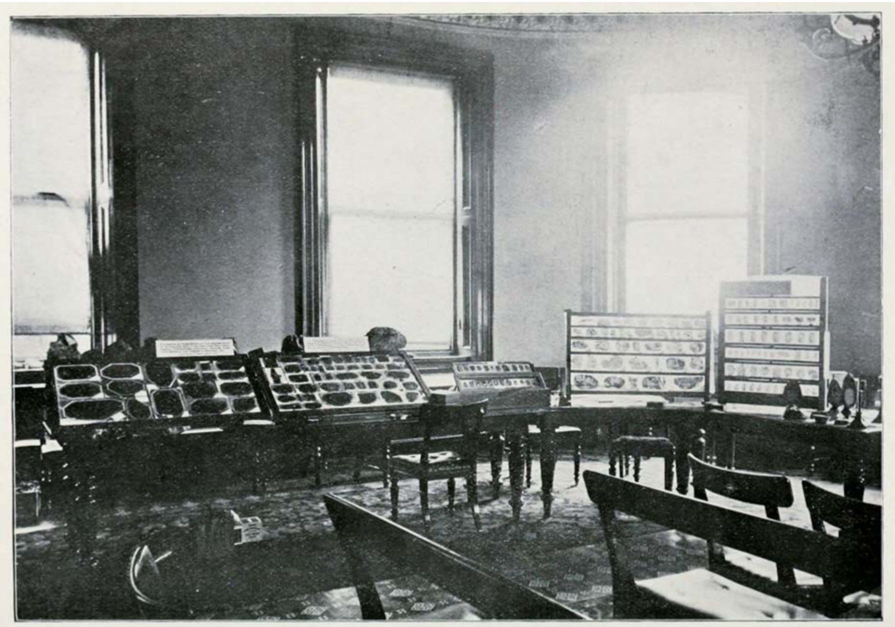
Scientific societies and meetings of all kinds, ecologists among them, were a natural extension of this ideal, and in such meetings, naturalists shared and exchanged objects and knowledge on a much larger scale. In addition to museum collections, to which many local scientific and naturalists' societies aspired, meetings, lectures and temporary exhibitions provided key venues for the display of objects. Here, naturalists could see and discuss individual specimens, and even whole collections, arranged according to appropriate

[50] Salmon 2000: 39

[51] Porritt 1883: 110. George Porritt, later President of the Huddersfield Naturalists' Society and of the Yorkshire Naturalist' Union, recalled taking specimens to Varley for 'naming', as a trepidatious boy, and received a half-dozen Emperor moth larvae in return. Mosley, a local weaver and joiner, was an expert in stuffing and mounting birds for display. He was also Varley's near neighbour in Almondbury Bank where his small house was crammed with cased collections of birds and insects, and where he regularly received viewing visitors, mostly working men, but also more affluent callers who paid him for his taxidermy and casing skills (Brooke 2012: 184-189).

[52] It is particularly striking how frequently the activities of naturalists, photographers, and the many others engaged in similar unpaid endeavours, were referred to as 'work' - a frequency which provides strong support for a the characterisation of such activities in terms of 'rational recreation'. But see also the following section for a discussion of the partial explanatory force 'rational recreation' for understanding amateur practice in such spheres of activity.

taxonomic principles. In such discussions, common understandings were forged, in which the prevalent theoretical structures of natural science were communicated to practical workers, amateurs as well as professionals. Accounts of such meetings and displays abound in the transactions of scientific and natural history societies throughout the 19th century. When the British Association for the Advancement of Science met in York, in 1906, however, James Lomax took the opportunity to record his display of a collection of fossil plant-remains from Yorkshire and Lancashire. The display attracted a good deal of attention and discussion at an evening conversazione held in the exhibition building.[53]



The Lomax Exhibition at York.

Fig. 6.6. The Lomax Collection, British Association for the Advancement of Science (York, 1906). From *The Naturalist* (1906: 347)

Similar soirées were common amongst regional and local scientific societies, and were clearly the progenitors for the soirées of the Huddersfield Naturalists Society and the British Ecological Society which were still thriving into the 1930s.[54] As we saw, especially in chapter 3,

[53] Recording not the objects themselves but their exhibition Lomax presented the act of display itself, registering a personal achievement and also a commercial interest. In early 1906, and with the support of a number of academic palaeobotanists, Lomax had launched the Lomax Palaeobotanical Company, dedicated to "the collection and preparation of fossil plants, both impressions and petrifactions, and their distribution for study and teaching purposes" (Howell 2005: 145). However, the Yorkshire Naturalists' Union (YNU) clearly shared Lomax's interest in promoting this kind of display and carried a full-page reproduction of the photograph in its journal *The Naturalist* (1906: 347)

[54] The model for almost all scientific meetings, by the latter half of the 19th century, was the Royal Society conversazione, where the visual display of natural objects, as in other fields of knowledge, quickly encompassed photographic representations, as part of a general currency of knowledge-exchange. These displays, which included live animals, zoological, geological and botanical

at such meetings naturalists and ecologists alike presented papers, photographs, lantern slide displays and exhibitions of natural objects gathered in the field. A reading of the transactions of any naturalists' society from the period reveals countless references to similar exhibitions and meetings, in which members presented each other with the findings of their collecting or other field activities.[55] In all these contexts, naturalist-collectors came together to exhibit and exchange natural objects, and to talk about their experiences in collecting. Through exchange, they shared knowledge, the skills and pleasures of identification and field-craft, and the requirements for the subsequent preservation and display of collected specimens, in what Jim Endersby has called the 'complex craft activity' of natural history, which all naturalists must acquire.[56] For most, these skills required long and exacting apprenticeship, much of which took place in the field and in front of collected specimens, in the company of more experienced naturalists. Natural objects in the field, and the specimens brought back from excursion, provided tokens or vouchers for the natural knowledge obtained and shared amongst dedicated naturalists at all levels of expertise. Moments of private exchange, between individual naturalists, have always been commonplace and the occasions where they took place are abundantly documented. They included a number of social and discursive spaces, from the 'field' to the meeting room and lecture hall, as well as in correspondence and in print publication. However, the evening meeting in particular was central to the functioning of almost all natural history societies, as it was for their literary and philosophical cousins and their antiquarian or photographic counterparts.[57] As others have pointed out, soirées,

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specimens, as well as paintings, drawings and photographs, made overt the close relationship between natural objects, their photographic surrogates and other forms of visual mediation. In 1896, exhibits included the first x-ray photographs of hands. In 1899, the skin of an extinct ground-sloth from Patagonia sat alongside colour photographs of zoological and botanical subjects, experiments demonstrating multiple vision, and photographs of stellar spectra. And a section of the soirée was routinely given over to lantern exhibitions which, in 1899, included lantern slides from the pioneering bird photographer Cherry Kearton; and slides by Henry Sorby of sea anemones and other marine animals. Reports of the annual conversazione were published in *Science* magazine. See Alberti 2003 for a fuller discussion.

[55] The West Kent Natural History, Microscopical, and Photographic Society, for just one example, in its annual reports summarised the year's meetings, where almost every instance is accompanied by reference to members' exhibiting, from butterflies to slow worms and fossils, caddis-worms, wild flowers and crystals (West Kent Natural History 1872-1887). Others have described similar indoor practices in natural history societies from Cornwall to Scotland (Naylor 2003, 2010; Finnegan 2005, 2009).

[56] Endersby 2008: 54.

[57] A small number of societies restricted themselves to field meetings, with no scheduled evening meetings or more formal gatherings. The Berwickshire Naturalists' club, for example, had no programme of indoor meetings, restricting itself to field activities. But even in these cases, like the working-class 'artisan botanists' described by Ann Secord (1994b), fieldwork was supplemented by

exhibitions, lantern lectures and so on, all served to develop and strengthen the sociality of natural history, but for most active naturalists they also validated a relationship to the field and provided the model for the similar social exchanges we saw among ecologists in chapter 3. During private and communal excursions, the 'field' provided a space in which real, felt knowledge was made and given primary structure, through direct experience shared with others. Indoor meeting facilitated the regulation and systematising of natural knowledge, but virtual witnessing was also a kind of virtual naturalising, a virtual excursion in which participants shared narratives of observation and the field objects of natural history and ecology. Whether indoors, or out and about, the sociality of naturalists authenticated not only the communal life of naturalist history. It validated practices of observation in common and the direct personal and shared experience of being in the field.

Such meetings commonly featured displays of both specimens *and* photographs, including prints showing objects or species in their natural settings — as well as lantern slide exhibitions, projecting not only photographs but natural objects themselves, such as butterfly wings mounted in glass slides.[58] Displays took place in a convivial setting, with much conversation and discussion, facilitating personal exchanges of knowledge and experience, of the specimens themselves and the relationships between them; how they should be preserved and displayed; and, just as importantly, of the personal experiences of collecting and field-excursion, and the places where such natural objects could be found. By the late 1890s, these dialogues were increasingly likely to take place over photographs of specimens, in place of natural objects. Whether among botanists or entomologists, ecologists or photographers, the objects of exchange and display at such events fulfilled similar functions in relation to 'natural' knowledge. At once material and representational, specimens and photographs alike evidenced the reality of the natural objects on show, and attested to their physical witnessing in the field.

Rational pleasures, affective objects, authentic places

Having briefly surveyed the extent and character of natural history practices of collecting and exchange, it is apparent that they shared much in common with those of photography and, by

social gatherings in a local public house. The Berwick naturalists commonly began the field-day with breakfast in the pub, ending again in the pub for dinner. Evening socializing invariably included discussions of the day's naturalizing and its more interesting finds, as well as occasional short papers on matters of interest to those gathered. (Britten 1873b: 39; Allen 1976: 145-146)

[58] Alberti 2003.

the end of the 19th century, the material practices of natural object exchanges were themselves inextricably bound together with related photographic practices. The deeply social character of these engagements with natural history and photography is also apparent. Individuals gathered together in pursuit of their enthusiasms in overwhelming numbers, giving rise to an extensive civic infrastructure for participation in popular science, photography and the arts. What is less clear is why individuals should come together in this way for field pursuits such as natural history or photography in particular, rather than the more comfortable and sedentary activities of, say, a literary society. If our ecologists seem to have receded somewhat from view at this point, it is because no-one has so far studied these questions of social exchange and civic engagement in ecological practice. Almost all early ecologists were also naturalists, however, and came into their scientific practice through the same institutions and social networks. It is worth staying a little longer, therefore, to consider the social and subjective practices of contemporary naturalists, to shed light on the likely experiences and motivations of their ecological brethren.

The great majority of natural history activity — and its associated exchanges of material and natural knowledge — took place in what David Allen has called "that masterpiece of social mechanics, the natural history field club."[59] Much of the success of these clubs, which proliferated especially in the second half of the 19th century, has been attributed to their social function. According to Allen, field clubs throve because, "though some naturalists are solitaries, most of them are sociable beings... [and because]... the very qualities that go to make a first-class naturalist - that instinctive love of order, system and detailed record; patience; unremitting care - were also qualities essential for the proper conduct of a society's affairs."[60] These attributes of sociability and orderliness have been widely recognised among social historians and historians of science as motivating factors for the widespread 19th century engagement with natural history. Yet, such attributes were surely not exclusive to natural historians; they were operational for all socially aware Victorians and Edwardians. Why then did only some take up field natural history or photography, whilst others stayed at home, or took up drawing, joined a literary society or gentlemen's club? Allen's socially oriented account sits within a larger explanatory framework for this interface between Victorian private sensibilities and civic action, commonly designated 'rational leisure' or 'rational recreation'.[61] The phrase denotes the pursuit

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[59] Allen 1976: 142.
[60] Ibid.: 155
[61] Secord 1994b; Alberti 2000, 2002; Finnegan 2005, 2009; Gouyon 2011 and others have applied the concept to various aspects of Victorian natural history practice in Britain; Denise Phillips (2003) has considered similar social foundations for regional natural history practice in 19th century in Germany.

of pleasurable or leisure activities with some morally 'improving', overarching purpose, as its justifying principle. 'Rational' leisure pursuits were regarded not only as morally improving and instructive for individual participants, but as the foundation for a wholesome civic society.[62]

'Rational recreation' as an idea is well evidenced in contemporary rhetoric surrounding popular science and a range of leisure activities, including natural history, archaeology, photography, cycling and sport and country walks, and there is little doubt that the idea carried moral force for many ordinary Victorians and Edwardians. Charles Withers and Diarmid Finnegan have even suggested that "to see scientific endeavour… as divorced from moral, recreational and educational questions would be to make a false distinction."[63] However, analysis of this kind effectively elides motivations other than moral and scientific instruction in the deceptively simple and misleading term 'recreation'. As a generalising concept, 'rational recreation' misses nuanced variations in the motivations for personal and civic practice and is insufficient to distinguish the success of natural history field clubs from any other kind of club or organised activity. There is an alternative view amateur practice which does not require us to abandon the general insights of an inquiry centred on rational recreation, but which allows for additional, individual subjective motivations centred on principles of 'pleasure'. In a convincing discussion of the rational civic basis for engagement in late nineteenth-century Scottish natural history societies, Diarmid Finnegan draws attention to a sustained 'recruitment rhetoric ' of idealistic promotion for natural history, as the expression of public duty, 'self-culture', moral and intellectual improvement.[64] He also alerts us to the rhetoric of pleasure in such sources, following Anne Secord in suggesting that Victorian naturalists sought to 'relocate the sites of pleasure' to spheres of activity that were specifically scientific and morally worthwhile.[65] "Pleasure, morality and self-improvement," Finnegan points out, "were run together with the disciplines of observing, careful and

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Simon Naylor (2010: 39-59) has provided a detailed commentary on the 'rational' aspects of 19th century Cornish civic science, including natural history. Jennifer Tucker (1996, 2005: 81) has incorporated 'rational recreation' into her accounts of 19th century science and spectacle, whilst the idea of 'rational recreation' also underpins Kuklick and Kohler's (1996: 6) notion of an epistemological touchstone for field science. The fullest, and most widely cited exposition of 'rational recreation' is still that given by Bailey (1978). Huggins and Mangan (2004) have sought to broaden the context of 'rational recreation' to reflect a more pluralistic reality in Victorian leisure but their critique relies heavily on the basic premise of 'rational recreation'.

62 The notion of a unitary bourgeois Victorian conception for civic society has itself come under question by some scholars. See, for example, Griffiths 2011.

63 Withers and Finnegan 2003 Withers and Finnegan 2003: 346.

64 Finnegan 2005.

65 Secord 2002: 32

systematic collecting, identification and appropriate display."[66] Yet his discussion pays little attention to pleasure, treating it as a self-evident, unproblematic category which is, effectively, subordinated to these 'higher' social categories of 'morality' and 'self-improvement'.

In these kinds of analysis, little attention is paid to 'recreation' as private pleasure. Common experiences of 'the field' are considered not as the personal subject encounters of those participating in field excursions and natural history exchanges, but as expressions of a broader social configuration of collective practice. Denise Phillips, who discusses the rational basis for regional natural history practice in 19th century Germany, also points out that "...talk of pleasure and beauty does not imply that regional natural history was the object of "mere" recreation.... Nineteenth-century regional naturalists also believed that knowledge and pleasure were intimately connected. For them, aesthetic enjoyment of local landscapes was rooted in careful scientific practice."[67] Even as Elizabeth Edwards describes the rational basis for photographic survey, as 'useful work', "premised on rational leisure, moral duty, and civic utility," she tells us that photographers themselves were not so easily regulated. They were often reluctant to work collectively and, more significantly, "the unfocussed qualities of photographers' intentions intervened at every stage."[68] The association of pleasure with field pursuits – from sport to science or photography – was also an expression of real pleasure in the embodied experience of outdoor activity, of exercise for body and mind. The pursuit of natural history, or photography or any other activity that engendered devoted, enthusiastic engagement was not a purely social matter; nor did self-identification as a naturalist or photographer resolve solely as a matter of 'rational recreation'. It encompassed the personal experience of engagement with the natural and human world, both as a physical reality and as a conceptual construct, as well as with the social reality of common practices in scientific and popular natural history. I am not here refusing the claim that the experiences and encounters of the field naturalist are, like those of the photographer, "both constitutive of and constituted through social relations."[69] But an understanding of how such relations are configured and made operative requires us to pay attention to the particular character of experience and encounter, as engagements between individual subjects and the object world.

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[66] Finnegan 2005: 56
[67] Phillips 2003: 59.
[68] Edwards 2012a: 63, 73, 75.
[69] Edwards 2012b: 221.

To do so, we must consider alternative motivations for naturalists' practices, other than those professed in terms of moral and social purpose.[70]

The practices of natural history collecting and exchange, and the interior debating spaces and print publications of local natural history, were ultimately defined and justified by activities in the field.[71] The great majority of meetings and lectures concerned objects and experiences derived from the field, to which participants looked for the authentication of their knowledge and the râison d'être of their meetings. These indoor and virtual spaces of natural history were also the sites where natural knowledge was formalised and regulated; where the unruly chaos of field experience — and of its social mediation — were 'ironed out', facilitating the detached, scientific reporting of observations which characterises the transactions and reports of field societies**.** The facade of scientific reporting was only rarely broken in such written account, where dry narratives and lists predominated, with little description beyond details of who went where, when, and what objects of interest they found or collected. On occasion, however, more informal accounts appear in society journals and, in the less constrained spaces of popular literature, practitioners were able to give expression to their subjective experiences of field observation, its craft and its encounters.

For example, an editorial for *Hardwicke's Science-Gossip* in 1866, devoted to the idea of "the hobby", suggests alternative ways to interrogate the activities of amateur naturalists, without easy recourse to the notion of 'rational recreation'.[72]

> Should you have a friend addicted to the habit of bringing home bits of wild flowers in his hat, mosses in his pocket, or occasionally be caught with a flat, brown, japanned sandwich box, when you know that he never carries sandwiches out in it, but will be seen to bring home many strange things in it, ask of him, as he plucks petal from petal — as simple girls are wont to do, in the hope of unsolving [*sic*] thereby some hidden mystery of the future—ask of him whether the pursuit of his study of plant-life, of wild flowers, of mosses, does not give an interest to every half-hour's stroll along a hedgerow or into a wood, which it would not otherwise possess; whether it has not given to him a new sense; whether it has not unfolded to him a new world.

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[70] The explanatory competence of 'rational recreation' has also been questioned by others in relation to other aspects of Victorian leisure. Alan Metcalfe (2006) has focussed on working-class life - and sport in particular - in the north-east of England. Mike Huggins and J.A. Mangan (2004) have reflected my own caution regarding too easy an acceptance of the contemporary discourses of 'rational recreation'.

[71] Contrary to Naylor 2002: 497, and Alberti 2000: 185

[72] *Hardwicke's Science-Gossip for 1865* (Cooke 1866: 2). Hardwicke's Science-Gossip was a popular magazine, subtitled *An Illustrated Medium of Interchange and Gossip for Students and Lovers of Nature.* It was essentially a scientific counterpart to the more literary *Notes and Queries* (*Nature*, 16 Feb. 1871).

And again, as the editor imagines an unanticipated encounter with a snake:

> Fancy oneself deeply intent, with nose unusually low, seeking the ruddy wild strawberry on a sunny hedgebank, and even whilst smacking the lips with the relish of the tart little fruit but lately conveyed there, about to pluck another yet larger and redder, when lo ! beneath our very fingers glides the sleek, attenuated form of the reptile—ay, within ten inches of our depressed nose. Under such circumstances, should we be surprised at finding ourselves starting back; at feeling a slight and momentary sensation, as of a drop of water trickling down our back.[73]

It would be easy to dismiss these kinds of texts as journalistic rhetoric, certainly the prose is somewhat florid and draws habitually upon commonplace metaphors and conventionalised romantic aesthetics (quotations from Emerson crop up repeatedly in this volume). In many ways, however, such outbursts are closer to the experiences of the field naturalist than the dry accounts of field excursions and scientific natural history work which appeared in contemporary journals and transactions. In this case, the writer emphasises value of field natural history for its potential to bestow heightened sensibility and unalloyed delight, through contact with the objects of nature. Even in the floweriness of the prose, he communicates the first-hand, embodied and intensely sensory experience of 'being-in' nature. Such sensory and pleasure-laden accounts of outdoor natural history abound in popular Victorian and Edwardian society journals. Nor should we assume that these sensory pleasures are restricted to dilettante naturalists or hedonistic 'nature-seekers'. Such societies included professional and academic botanists and ecologists, whose motivations in this respect we have no reason to assume were any different to those of their amateur fellows. The field journals of professional naturalists, diaries and memoirs, are filled with similar accounts of the delights of encounter and immersion in the phenomena of the natural world.

These more subjective accounts reveal an affective aspect to the practices of natural history, which is normally written out of their scientific reporting. Yet, this affective aspect has always been the animating spirit for natural history and is evident especially in the relationship between naturalists and their objects of study. Charles Darwin, wrote of "the passion for collecting which leads a man to be a systematic naturalist;"[74] and Alfred Russel Wallace reported suffering a severe headache from the excitement of finding a new species of birdwing butterfly in Indonesia in 1859. "The beauty and brilliancy of this insect are indescribable,' he wrote later, "and none but a naturalist can understand the intense

[73] Cooke 1866: 2

[74] Charles Darwin, *Life and Letters* (1887, 1: 28).

excitement I experienced."[75] Wallace's physical elation was such that he suffered a headache for the rest of the day. Whilst perhaps less celebrated than these two giants of natural history, the Yorkshireman George Porritt was no less passionate a naturalist. In his Presidential Address to the Yorkshire Naturalists' Union in 1900, Porritt summarised the values of natural history collections. He gave primacy to the acquisition of regulated knowledge, insured by an ethic of communality, social responsibility, and the sharing of knowledge by proper recording. In these terms, he reflected with clarity the rhetoric of rational scientific endeavour. "No naturalist will for a moment deny the use of collections" he said, "...at once standards of reference, and...necessities for biological research; they are indispensable for a proper study of the variation, distribution, and ...origin of ...species; they are instruments of civilization by which our thoughts are widened." But he couldn't resist alluding also to the basic pleasures of the field, sensory and social, and the capacity of collected objects to represent or re-evoke those pleasures in memory. In addition to reviewing the rational benefits of collecting and recording, therefore, he spoke of "the intense pleasure and relaxation with which we regard [collections], when every specimen brings back to our mind some enjoyable outing, or associates some place, probably a lovely wood, or mountain, heath, marsh, river side, or stream, where with some friend,—possibly now gone to his rest —we captured or found these identical specimens."[76] This recognition of an intensely personal motivation in collecting, and in the desire to share the knowledge and pleasures obtained through direct experience, is essential to any understanding of natural history at the level of the practicing subject, and is the testing ground for any more generalised analytical categories at the level of the social.

The site of knowledge for such naturalists was associated with personal contact with the object of study. As the editor of *Science-Gossip* declared in 1876: "The great end of natural-history reading should be the development of a love for the objects dwelt upon, and a desire to know more about them."[77] This love for natural objects was induced by direct contact in the field. It is evident — amidst the dry lists of species and excursion itineraries which dominated society journals — in evocative glimpses of the embodied experiences of field study, which encompassed both natural objects and photography. In 1891 for example, Yorkshire naturalist the Reverend W.C. Hey published in the journal of the Yorkshire Naturalists' Union "Some

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[75] Wallace 1869: *51.*
[76] Porritt 1900: 98. Porritt's paper was an amplified form of an earlier address as president of the Huddersfield Naturalists' and Photographic Society in 1898.
[77] Taylor 1876.

word-pictures taken from nature".[78] Trading on the presumed mechanical objectivity of the photograph, he described his 'word-pictures' as 'verbal photographs', and espoused the need for close observation and accuracy, whilst conveying his own poetic impressions of the direct experience of 'natural scenery'. Most descriptions of such scenery failed, he claimed, because they were based on memory impressions, not recorded observations. He presented his own 'word-pictures' in the manner of photographs, each preceded by a simple caption-like heading, such as *April 26th, 1890. In Saltburn Glen.* He augmented the photographic conceit with descriptions, expressed in the present tense, in which the author appears in the first person, in what amount to 'photographic' self-portraits. These descriptions have the merit, he says, like photographs, that *they were taken out of doors and on the spot.* The descriptions themselves overflow with aesthetic and sensory detail and moments of engagement with the natural world. One short example will demonstrate:

> **Sep. 20th, 1890. Danes' Dyke (North End)**
> I am lying by a stile under shelter of the great grassy end of Danes' Dyke, a fresh south-east breeze blowing, a warm and sunny wind, putting a thousand little snowy crests upon the ripples of a brilliant satiny green-blue sea, with great purple patches on its surface. The horizon ends vaporously. A few white clouds of very irregular shapes float in a pale blue sky. Now and again I hear the sea-gulls cry, and a few birds appear above the cliff; with snowy breasts and dark wings. By me the thistles shake silvery plumes against the sea; dried stems of Holcus tremble in the wind; flies settle upon them with great brown eyes; hundreds of little gnats flit in the sunshine; now and again the buzz of larger insects goes by. Behind me is a sheep pasture, a faded field with dark masses of gorse. The sheep are feeding so busily that they are silent, but the waves below are clamorous, a seething, and a perpetual roaring beneath the seething, both continuous and unvarying at this height.

Elsewhere in the Union's journal, the reporting style for excursions tended to be less figurative, often consisting of extensive lists of species found and collected, and equally extensive itineraries describing the routes taken, the members of the party attending, and where stops were made for food and refreshment. In July 1903, for example, reporting a trip to Filey, Thomas Sheppard gave attendance details, the places visited and the 'important finds' made there.[79] These accounts foregrounded the sociability of the Union's activities, and the spare style of reporting often obscured the likely excitement that such discoveries were likely to engender. Individual contributors to the journal did occasionally try to express their enthusiasms, for the places they visited and the practice of their skills, but ordinary naturalists often felt themselves falling short of the task. John Farrah might have envied the Rev. Hey's

[78] Hey 1891.
[79] Sheppard 1903c.

prolixity when he described the Union's botanical excursion to Bowes in September 1903.[80] He lamented his lack of expressive language. "Just now," he wrote," I wish for the descriptive power of Scott or Richard Jefferies, so that I might do slight justice to the many charms of this historic and picturesque part of grand old Yorkshire." In his ensuing attempts, the prose is deeply conventional and stilted, but the formulaic veneer decorates a genuine enthusiasm, and a desire to communicate the experience of 'being there'.

> The main body of the naturalists had gone to Deepdale. The weather was glorious, brilliant sunshine, fresh west wind, and magnificent cloud effects. Occasionally a huge rain cloud obscured the sun for a few minutes, sprinkling upon the landscape and upon us a few drops as a parting blessing before being absorbed into the surrounding atmosphere. Stately piles of cumulus, like snow-capp'd mountains, ranged in irregular order the circle of the horizon, no words can describe the subtlety of their colouring, and only the pencil of a Turner could faintly depict them. Under these conditions life is ideal, and we feel sorry that there are not more lovers of nature and fewer jerry-builders.[81]

In his enthusiasm for the authentic experience of nature, tied to the particular places of field-study, Farrah indicated a desire to escape such conventional expression, declaring the 'true naturalist's' preference for nature's "wantonness and waywardness" over the artificial and man-made. "The naturalist turns to his wildlings to make his soul rejoice," he continued. "This, I think, proves that a genuine naturalist is only a partly-reclaimed savage; it is impossible for a real naturalist to love conventionality or even to tolerate it."[82]

Denise Phillips has noted similar enthusiasms among 19th century German naturalists, for whom natural history took meaning from an intimate connection between scientific practice and the aesthetic pleasure of local natural landscapes. Like those of Yorkshire naturalists, the "terse lists and indexes" of their accounts of field excursions "hid a set of practices with great moral, epistemological, and sometimes even political depth. Through regional naturalists' habitual hikes and excursions, these compilations remained closely interwoven with the spaces of their creation."[83] Elizabeth Edwards has described in similar terms the embodied excursion practices of amateur survey photographers, which "encompassed not only the act of making photographs itself, but the experienced environment."[84] Looking beneath the surface accounts of the excursion, Edwards excavates the subjective and affective experiences of field practice among photographers who, after all, borrowed their sensibilities - together

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[80] Farrah 1903.
[81] Ibid.: 361-362.
[82] Ibid.: 363.
[83] Phillips 2003: 59.
[84] Edwards 2013.

with the sociality of their practice – from the geologists, botanists, naturalists and antiquarians who preceded them. She observes an "enormous sense of the presence of the photographer as spatially embodied."[85] The Rev. Hey's 'word-pictures' are particularly interesting from this perspective, since they self-consciously bring together the embodied presence of the naturalist and the sensibilities of the 'photographer', in the intense observation of particular localities. Edwards encourages us to challenge the "strange disjunction or disembodiment" which has come to dominate practices of knowledge and representation. This is most effectively achieved by re-linking photography to its related practices — what she calls "self-conscious and imaginative acts of inscription"[86] — whether natural history, or the imaginative historicism of survey photography.

The polemics of 'useful leisure' and 'rational recreation' should be seen in part as rationalisations for the affective and sensory pleasures of physical exercise and sensual engagement with certain kinds of environment — associated with escape, community identity, heritage (natural and anthropogenic), and continuity — all of which were embedded in ideas of the English landscape. The layering of civic value over the 'ramble' had the effect of validating the pleasure of the excursion as serious, educational endeavour. Values relating to scientific observation, healthful and constructive leisure, education and so on, overlay and obscure these embodied motivations. But an ethnographic inquiry, examining the experience of participants in such excursions — through written accounts, but also through the objects they studied and collected, both natural and photographic — begins to uncover these less civic, more personal pleasures. Like amateur photographers, amateur naturalists, professional botanists and ecologists engaged in private and collective field excursions, immersed themselves in the sensory fullness of their places of study and in the experience and knowledge of their fellows. The sociability of such excursions, and their subsequent rehearsal at indoor meetings, facilitated exchanges of knowledge about the subject of study, but also about the ways in which such knowledge could be obtained and secured, through prescribed practices of observation, collecting, preservation and display. Equally importantly, the rewards of sociability were combined with subjective experience (collective and personal) of the immediate presence of the object of study, in its 'natural' outdoor setting. As we saw for ecologists in BVC field visits, or BES Summer Meetings, the experience of natural history in general was tied to the specificity of particular places and the things witnessed there, through

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[85] Edwards 2014b: 180.
[86] Ibid.: 179-180.

intellectual engagement and careful observation, but also through embodied and emotional interaction. Both natural objects and photographs, collected in the field, provided memorial surrogates for the experience and knowledge of these places. They were records of observable facts, but also of personal, affective encounter with those facts. As Joan Schwartz tells us, "the facts offered by photographs were believed to be accurate, complete, and capable of producing reliable knowledge of the world. [But] photographs were also assumed to capture the feelings of association, [and] the spirit of place..."[87]

Natural objects of photography

The Rev. Alfred Thornley, writing in *The Naturalist* in 1903, summarised the value of photography to the ecologically-minded field naturalist.

> What great use might be made of the camera in connection with the attitudes of birds, or the positions of leaves and flowers at different times of the day. I recently saw a beautiful lantern slide of a field of sleeping daisies, and then the same wide awake in the morning. I once had given a pretty photo of a Leaf-cutter Bee at work on a rose tree; and I have seen lately a wonderful slide of two butterflies asleep on a flower, and covered with dew drops. In infinite ways the camera might be made to do us great service. What could be more suitable for museum decoration than a fine series of Nature photographs? But the subjects are infinite which may rightly engage the attention of naturalists, and all have to do with the relation of living things to their environment— a conception now conveniently expressed by the term 'bionomics.'[88]

Rev. Thornley extended his remarks, effectively to suggest that photography, as a technology of observation, might even supersede collecting as *the* requisite practice for natural knowledge. "Mimicry, pollination, instincts, the movements and attitudes of plants and animals" he wrote, "such studies as these, as well as accumulating an accurate series of records, invaluable for the purposes of distributional zoology, will afford plenty of opportunity for [photographic] work. Too often one gets from individuals the laconic reply, 'I do not collect anything,' to which one feels inclined to make answer, 'My friend, you are not required to collect anything, but to observe everything.'"

The alignment of interests between naturalists and photographers, as we have seen, was evident soon after photography's first public disclosure. The West Kent Natural History, Microscopical and Photographic Society had incorporated photography into the existing naturalists' society as early as 1863. But from the 1880s and 1890s, the association was given a

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[87] Schwartz 2006: 76.

[88] Thornley 1903. The term 'bionomics' was in currency amongst some British biologists for much of the first half of the20th century but has since been superseded by the more widely accepted term of 'ecology.'

new impetus, by a combination of technological innovation and new ethical outlook on collecting and its natural objects. Likewise, from 1892, as we saw in chapter 3, the Huddersfield Naturalists' Society combined with the Huddersfield Photographic society to form a single club and, whilst this did not indicate a complete congruence of activities or enthusiasms between the two groups, it did mark a significant confluence of interests, which was repeated widely elsewhere. We have also seen that an increasing number of individuals began to combine their natural history with photographic practice. From the 1890s onwards, naturalists were increasingly conscious of the damage caused to the objects and places of their enthusiasm by widespread and indiscriminate collecting. At the same time, the stimulus of technological innovation assisted natural history photography to become a significant contributor to the exchanges of photographs which were already a commonplace of photographic networks. In the Edwardian period especially, nature photography became much more popular and widespread, partly in response to the increasing availability of fast lenses, rapid mechanical shutters and faster emulsions, first as 'dry-plate' and then film. These new photographic technologies transformed the activity of collecting for many naturalists, promoting a new ethical collecting practice, as they turned to the camera, instead of the gun or the killing-jar.[89]

Martin Rudwick, whose influential paper on the visual language of geology first opened the possibilities for a visual history of field sciences, has explained the use of pictures by geographers and geologists as 'proxies' for field experience, by faithfully reproducing "what the primary observer had seen in the field, making that experience convincing to others and thereby converting them into virtual witnesses."[90] The shift to photographic collecting was especially attractive for naturalists whose subject was inherently difficult to collect and display through material objects. As we have seen throughout this thesis, ecologists had begun to focus attention on habitats and whole stands of vegetation, rather than individual species, and clearly could not 'collect' their objects of study in the traditional naturalists' way. Ornithologists, similarly, embraced photography as a means to show wild birds and their behaviour in natural settings, objects of study that could not be collected and displayed in any other way. Photography gave these naturalists a new method for observing and collecting, with all the challenge and excitement of earlier methods, but without the consequential death

[89] Thomas Dallmeyer had already made a special naturalist's camera and, in 1891, had introduced the first telephoto lens.

[90] Rudwick 2005: 76

and depletion of valued natural objects. For the remainder of this chapter, I want to consider a few examples of the expression of affective encounter with the objects and knowledge of ecology and natural history, and its mediation through the observational records of photography. My examples are not restricted to ecologists or vegetation study, and this is deliberate, to make clear the commonality of embodied experience entailed in field study across a range of natural histories, especially as it was played out in photographic practice. These examples suggest that photographic practices, and the practices of object collecting they replaced fulfilled similar functions, as a mode of knowledge exchange, as registers of field skills, and of subjective engagement with the natural world. Naturalist-photographers went out into the field and returned with picture proxies for what they saw, but their pictures were surrogates not only for visual witnessing, but for field experience more widely.[91] In these examples, the evidential and aesthetic aspects of photography are allied to verbal accounts of fieldwork, in which natural objects and their photographic representation are woven together with the subjective experiences of encounter, and immersion in the natural world; they are, essentially, performances in scientific natural history.

My first example comes from an account of ecological survey work in 1914, in which Augusta Lamont wrote an extended description of the plant communities and ecological conditions of a Scottish estate. Framed as a scientific account, "...a desire... to attain, by means of original observation, some insight into that great and attractive field of botanical science known as ecology,"[92] the description is laid out systematically to provide a rational picture of physical conditions and vegetation, in a progressive sequence from seashore to mountain top. But Lamont's account is also littered with observations and exclamations which appeal to an aesthetic and sensory experience of place. In amongst dry lists of plant species and ecological conditions, she gives us a case study in visuality and the sensuality of landscape and field experience. She takes her readers on a guided walk, observing and experiencing first-hand the landscape and its vegetation, with frequent reference to their sensory qualities. She notes the 'inhospitability' of some environments on the estate; and the landscape's distinctive colouring, "beautiful in its collective distant effects of purple, green, and brown,"[93] as well as the textural and haptic qualities of the vegetation. In a Wordsworthian register, she

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[91] I have borrowed here from the phrase 'proxy pictures', used by Rudwick (ibid.: 75-76) to describe pictorial illustrations which *"served effectively as proxies—standing in for the real thing...making that experience convincing to others and thereby converting them into virtual witnesses."*
[92] Lamont 1914: 273.
[93] Ibid.: 255.

declares her review to be "the result of many lonely rambles... the outcome of an appreciation for, and interest in, the wild plants in their native haunts where natural beauty is still unspoiled by the devastating hand of civilisation."[94]

Fig. 6.7. Augusta Lamont. "The Ecology of Knockdow Estate, Argyllshire". *Transactions of the Botanical Society of Edinburgh, 1914.*

The landscape Lamont describes as 'native' and 'undisturbed' is in fact far from natural. It is subject to sheep-grazing, heather-burning, grouse shooting and forestry, and her appeal to naturalness, expressed as a conventionalised, romantic notion of the Scottish landscape, is deployed here to convey a subjective, intensely personal experience of the 'wild' open space of the hill. The account is accompanied by two maps and several photographs (Fig. 6.7), which provide visual evidence for the vegetation communities described, but just as importantly, they show the *places* where these communities were seen and felt during the 'many lonely rambles' of her survey. Taken together, the photographs and text resolve as an attempt to

[94] Ibid.: 273.

share both scientific knowledge *and* subjective experience, in support of an ethical valuing of place.

Fig. 6.8. Philip Bahr, *Osprey Flying Down to Nest*, *1906. British Birds*, 1908.

Visiting North America to study ospreys in 1906, Philip Bahr confirmed the transition from gun to camera as a means of collecting natural history knowledge (Fig. 6.8). Writing an account of his study for a new magazine for ornithologists, he observed: "It is perhaps fitting that the first number of *British Birds* should contain an account of a bird which, as a breeding species in these islands, is reduced to a solitary pair or so...such is the heritage of the modern ornithologist! What trap and gun have not attained, the collector's zeal has accomplished." He also displayed an amateur ornithologist's enthusiasm, exclaiming that "to see some 300 pairs of these lovely birds congregating in one spot to breed is an awe-inspiring sight."[95]

His account is rich in visual and sensory detail, intended to convey the truth of experience and an authentic response to the natural world, including picturesque trees, the detailed structure of an osprey's nest, and the 'intolerable' stench of decomposing fish around the nest. These are accompanied by minute behavioural observations and anecdotes, which serve

[95] Bahr 1908. The flight of ornithologists from the gun to the camera was a common theme. Many declared their newfound preference for photography over shooting when presenting their work to others. Noted Yorkshire ornithologist Riley Fortune, for example, declared to his audience of Huddersfield Naturalists in 1903 that studying 'Bird Life from a Photographic Tent' had completely killed his love for a gun. (HNPS Annual Report 1919-20, Huddersfield Local Studies Library).

to communicate the experience of working in the field, both as an acute ornithological observer and as a sensory human being.

> [The nest] contained, besides sticks and bundles of seaweed, fragments of many a wreck, a pheasant's skeleton, a wheel of a child's mailcart, and… such unconsidered trifles as corks of bottles…
>
> While lying in bed in our hut, on the edge of an inlet of the sea, I could, in the early mornings, hear the Ospreys plunging quite close; splash after splash resounded, one about every two minutes…
>
> Of these eggs I shall ever bear a lasting remembrance, for long exposure to the hot rays of the sun had rendered them somewhat "high," a fact which was emphasized when one exploded in my hand, and the contents were discharged all over my face…[96]

The role of photography, as a medium of record and representation, but also in the direct experience of field-study, is also prominent in the text:

> By means of an umbrella enveloped in green cloth, my companion, Mr. C. G. Abbott, was enabled to study the home life of this noble bird at a distance of some twelve feet. It took, however, two of us to deceive completely the anxious parent. One would fasten the other into the structure we politely termed a tent, and then walk ostentatiously away. Having once discovered that danger lurked inside the tent, the bird would refuse to return for the rest of the day, and it was useless to persevere. A much more rapid and certain way of obtaining photographs was to lie partly concealed and watch, at a short range, through field glasses. Then, so familiar were they with the sight of man, that the Ospreys would return to their nests when we were hardly a hundred yards away. When the heat on the beach became unbearable we would retire into the sea, and from that cool resort were enabled to pull the string attached to the camera, and so take many of our best photographs.[97]

This kind of observation, from ornithologists and other naturalists, are strongly associated with the experience of particular places. As Edwardian nature writer W.H. Hudson wrote, speculating in 1913 on the "the peculiar delight produced in us by the sight and sound of birds…It is to taste this feeling that thousands of persons, some with the pretext of bird-study or photography, annually visit these teeming stations within the kingdom, whilst others who are able to go further afield seek out the great bird haunts in other countries.…This rather than the notes and bundle of photographs which they bring back is what they have gone out to seek."[98] Hudson was no fan of the camera and here asserts the primacy of experience over its record. Nevertheless, for many, the "notes and bundles of photographs" retrieved from such encounters serve a similar function in the reflexive mediation of experience and memory as that achieved by Hudson's own intensely descriptive texts. Even when an ornithological

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[96] Ibid.: 18, 21, 43.
[97] Ibid.: 40.
[98] Hudson 1913: 41-42

photographer concentrates her pictorial attention on a particular species, a particular animal, the interaction is grounded in a specific locality.

The value of such localities for ornithology is apparent in their common recognition amongst birders as 'good' places to watch and photograph birds. Through this recognition, photographs of individual birds — and ornithologist-photographers — are linked through a networked knowledge of valued 'birding' sites. The return of a rare bird to one of her favourite watching haunts in 1907, therefore, was inevitably a moment of energetic enthusiasm for Emma Turner.[99] "My excitement was intense," she wrote, "when about two o'clock in the afternoon of June 13th last, a keeper suddenly dropped into my cabin, without announcing himself, and told me he had found a Reeve's nest containing four eggs. We set off at once with my camera and in a very short time I was standing about eight feet from the sitting bird."[100] At Turner's request, the keeper returned to the cabin for a hand-camera whilst she remained in place to mark the spot and to fix the moment in her experience. Close observation and bodily proximity were the essential properties of this kind of field experience; only by such practices could the hidden wonders and miracles of nature be revealed and experienced. Turner's account also as a personal encounter, a personal relationship with the bird, in which the cryptic and hidden aspects of nature seem especially rewarding for the field observer. "At first I could barely see her…she seemed as a part of the surrounding herbage…we remained motionless some time, the Reeve and myself, while the keeper returned to the cabin for a hand camera."

Setting aside the class relations implicit in this report, I want to focus on the implications of the *photographic* encounter with a nesting bird. Turner's use of a hand camera, with its relatively informal, less 'pictorial' style, can be understood as a desire to record an encounter which is relatively unmediated, compared to those obtained with a field camera using quarter or half plates. In the event, the bird flew off before the hand-camera arrived, but what happened next is interesting, because it was at this moment that Turner's *serious* photographic practice began. The real, unmediated experience of connection with nature (something of which the hand camera might have captured, had it arrived in time) was over.

[99] Turner 1907.
[100] Ibid.: 65.

But Turner now set about re-staging the encounter for the more considered picture-making of the field camera (Fig. 6.9).[101]

REEVE GOING ON TO HER NEST.

(Photographed by Miss E. L. Turner, in Norfolk, on June 18th, 1907.)

Fig. 6.9. Emma Turner, *Reeve Going on to Her Nest, 1907*, *British Birds*, 1908.

The nest was moved slightly, to better photographic advantage, and its eggs were swapped with those of a less rare redshank's nest, so that the unwitting redshank would sit on the reeve's eggs whilst Turner made her photographic preparations. An account then follows of the difficult process of re-staging and capturing the 'natural' moment, including several

[101] The hand camera is a more flexible and versatile technology for such encounters than the unwieldy 'field' camera, which is larger, heavier and generally mounted on a tripod. The 'hand' camera, because it can be used quickly and in circumstances where a cumbersome, tripod -mounted field camera cannot, can be understood as permitting the natural history photographer to record an encounter which is relatively unmediated. The resulting pictures are likely to be less 'pictorial', and may even lack descriptive clarity, compared to those obtained with a field camera using quarter or half plates, where greater image resolution and compositional rigour combine to permit picture-making for detailed description and which meets the genre conventions and aesthetic effects of 'nature photography'.

failed attempts - over several days. In the account, which is full of sensory details of the nest site, and of hours spent hidden beneath an oilskin, heaped with sedges and grass, Turner recounts a performance in which both the 'natural' encounter, and its mediation through photography, are re-staged for the reader.

Fig. 6.10. Richard Kearton. An artificial tree trunk used as a hide. From *Wild life at home*, 1898.

Writing in 1898, Richard Kearton reflected a similar engagement with the field-experience of photography, declaring, "No one can possibly know the fascination of stalking wild creatures in their native haunts with the camera except the man who has himself indulged in the sport."[102] Richard and his brother Cherry were undoubtedly the most celebrated naturalist photographers of the early 20th century, and perhaps the most innovative. They published numerous popular books (Richard was the primary writer, his brother the main photographer) and were in high demand as lecturers, giving frequent lantern slide shows and appearances at conversazioni and exhibitions. Their popularity was long-lived; David Attenborough has cited

[102] Kearton 1898: viii

them as an early influence on his own long career as a natural history film-maker.[103] Their innovations included the use of many elaborate devices for concealing themselves from their photographic subjects - including camouflage, wooden screens, rocks, and vegetation - and even an artificial tree trunk (Fig. 6.10). Their most celebrated 'hide' was, quite literally, the hide of an ox, stretched over a wooden frame, allowing the concealed photographer to take pictures through an opening in the beast's chest. These extravagant ruses were essential for obtaining close, naturalistic pictures of their subjects but, like Bahr's osprey encounters, the reporting of the Keartons' adventures emphasised direct field-experience, bound within a narrative of encounter and natural history performance. On occasion, the original performance may even require re-staging — for example when Richard lost his balance and was stuck in the ox-hide for an hour (Fig. 6.11 overleaf). If the story is not apocryphal, it seems likely that Cherry first rescued his brother before re-creating the incident for the camera.

Notwithstanding this kind of light-hearted story-telling, the Keartons were at pains to emphasise the serious intent of their photographic activities. They presented their work as first-hand nature-study, pleasurable but also instructional, "solace to the mind and health to the body,"[104] but also, crucially, as hard labour and perseverance. "We have slept for nights together in empty houses and old ruins," Richard wrote, "descended beetling cliffs, swum to isolated rocks, waded rivers and bogs, climbed lofty trees, lain in wet heather for hours at a stretch, tramped many weary miles in the dark, spent nights in the open air on lonely islands and solitary moors, endured the pangs of hunger and thirst and the torturing stings of insects, waited for days and days together for a single picture, and been nearly drowned, both figuratively and literally; yet such is the fascination of our subject that we have endured all these and other inconveniences with the utmost cheerfulness."[105]

Trading on these kinds of physical escapade, the Keartons' accounts of their photographic exploits emphasised photography's value as a surrogate for natural history collecting, and for hunting, as a "new form of sport...yielding permanent trophies of the skill and endurance of its votaries."[106] The narrative was naturally appealing for a popular audience;

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[103] Attenborough is just one of the many honoured by the Royal Geographical Society, with its Cherry Kearton Medal and Award, for travellers "concerned with the study or practice of natural history, with a preference for those with an interest in nature photography, art or cinematography" en.wikipedia.org/wiki/Royal_Geographical_Society [Accessed 12 June 2016].

[104] Kearton 1898: vii-viii

[105] Kearton and Kearton 1898: vii-viii

[106] Kearton 1898: ix

Fig. 6.11. Richard and Cherry Kearton. 'Ox-hide in operation' and 'Ox-hide unbalanced'. From *Wild Nature's Ways*, 1903.

but the caricature "derring-do" of the ornithological photographer was also an index of authenticity, for the intensely embodied character of natural history fieldwork.[107] Accounts of bird photography as a kind of extreme sport reveal the strong performative basis for the exchange of these kinds of natural knowledge and field experience. Its products — photographs — were trophies of sport, objects of natural knowledge, and evidence of its winning.[108]

These performative and affective aspects of natural history and photography were not restricted to amateur or popular naturalists; they were every bit as active amongst professional scientific fieldworkers. In chapter 5, I considered the central importance of vegetation survey in the early British ecological project, and the significant ontological and epistemological relations between the resulting practices in mapping and photography. Arthur Tansley had characterised *survey* work as the first essential 'descriptive stage' of vegetation ecology and highlighted the spatial and visual character of plant associations. We saw Tansley surveying in Devon woodlands in 1906 and again in the 1930s. His field practices of note-taking, photography and cartographic sketching revealed a particular way of walking and working in the field; a profoundly embodied mode of knowledge-making. The photograph from Tansley's fieldwork in the 1930s registered this embodied cognition (Fig. 5.7). Even as it recorded scientific survey work – field ecology in practice — the photograph functioned also as evidence for the ecological object of study, and as a surrogate for its sensory registration – literally, seeing the woodland plant community.

In August 1910, Tansley visited Rothiemurchus Forest in Aviemore, Scotland. As he skirted the shore of Loch Eilein, map in hand, he interrupted his walk to make a sketch (Fig. 6.12 overleaf), plotting the rough altitudinal limits of tree growth in the natural Scots pine forests clothing the hills beyond the lake. Continuing beyond the Loch the following day, he climbed the hill beyond, making notes as he went and pausing again to take a photograph, at the limit of tree growth, looking back towards the spot where he had sketched the day before (Fig. 6.13 overleaf). Once again here, the use of map, scientific observation and visual record combine as mutually supporting evidence for the ecological survey. But the importance of physical and sensory engagement in such surveys became particularly apparent when Tansley re-visited the site in 1937.

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[107] Kearton and Kearton 1898: 66.
[108] Kearton 1898: viii-ix.

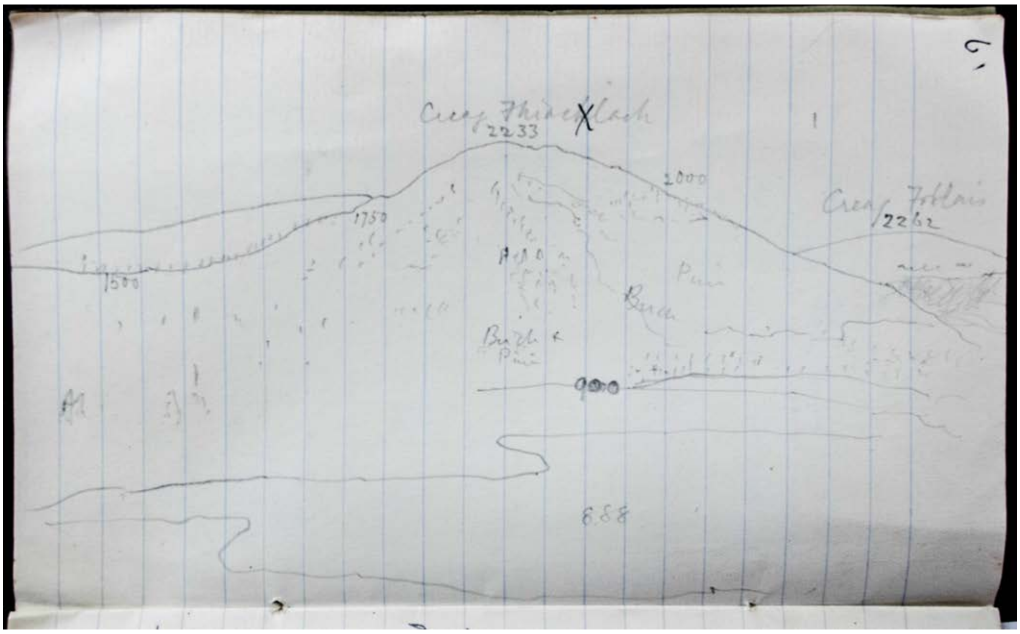

Fig. 6.12. Topographic sketch. Rothiemurchus Forest, Aviemore. 14 August 1910. Field notebook, A6+. Tansley Papers, Cambridge University Library. B.21

Fig. 6.13. North-west slope of Creag Fhiaclach at 1650ft. Rothiemurchus Forest, Aviemore. 15 August 1910. From *The British Islands and their Vegetation*, 1939.

Arriving late in the day, he and his junior colleagues were already tired, but Tansley insisted on taking the same extended route around the loch as he had walked 27 years before. This illogical tour, the long-way around the loch, when both he and the rest of his party were already tired, reveals the role of repetition in the practices of scientific observation, but also the profoundly embodied and visual experience of ecological fieldwork. Tansley walked a route previously trod, re-tracing the course of earlier observations, taking the party on the same progression through the landscape, encountering the same physical topography and vegetation types he had experienced and recorded years before - literally, repeating the view. This physical and visual reprise had the effect of repeating and re-inforcing Tansley's own earlier observations, it also tacitly communicated his prior experience and knowledge to the other members of the party. Incidents like this suggest the experience of ecological fieldwork as a kind of imprinting, in which visual observation and bodily experience in the landscape cohere in a sensory and cognitive whole capable of conveying both scientific and personal meaning.

In natural history collecting, the meaning of objects lay not only in the characteristics of the objects themselves, but in the experience of collecting, which begins with encounter and continues through a series of cultural and discursive transformations, re-inscriptions and re-contextualisations. Throughout the 18th and 19th centuries, natural objects fulfilled the same functions that came to be active in nature photographs by the beginning of the 20th century. They mediated knowledge, social and cultural and meanings, and private subjectivities. These points of intersection, between the practices of natural history and those of photography, provide reciprocal illumination of the social and epistemological fabric of amateur science and photography. Both sets of practices were mediated through communal organisations, which reflected class hierarchies and social aspiration to the privileged discourses and social contexts of science and art. Both also carried the stamp of Victorian scientific thinking, with its emphasis on regulated knowledge and the systematic organisation of objects into hierarchical taxonomies; and both were firmly embedded in the ethical ideologies of rational recreation and useful leisure.

At a practical level, they entailed similar activities of collecting, sorting, arranging, preserving, exchanging and displaying objects, natural and photographic. These similarities were also experiential, however, at the level of material and sensory engagement, in the field and in the lab, the darkroom and the lecture hall. Both were engaged in regulated field practices for collecting, which entailed particular experiences of movement, sociability, sensory and intellectual engagement. Both gave primacy to the visual mediation of field experience, both in the first-hand experience of natural history or photography in the field subject, and in its subsequent representation and display. Their collected objects were subject to equally regulated methods for processing, preservation and presentation — preparing and mounting natural history specimens, or preparing lab sections, can be seen as analogous to darkroom practices for photographic processing and printing. Natural history objects and photographs alike were arranged and stored in archives and ordered collections; they were mounted, displayed and exhibited in similar social and disciplinary contexts. So similar were these uses and attendant practices that natural specimens and photographs could be directly interchangeable. For both types of practitioner, the exchange of 'natural products' were consciously intended as a means of sharing knowledge and experience, and for promoting a common appreciation of particular values — scientific, aesthetic and cultural — as *prima-facie* justification for their practice.

Photographs are matters of record, documents of knowledge. Like natural objects, they are also tokens of experience; sensory, psychological and social. As Jennifer Tucker wrote "The Photographic Exchange Club pictures were as much records of hours devoted to the enjoyment of natural beauty and antiquities, and of the art of photography, as they were pictures of particular things or places."[109] For Victorian and Edwardian naturalists, collecting and photographing were not simply manifestations of an 'acquisitive mood'.[110] Specimens and photographs provided surrogates for knowledge and experience obtained in the performances of natural history. Natural objects, and their photographic equivalents, contributed to a common knowledge of natural history, and facilitated participation in a community of scientifically motivated practitioners of the field. They communicated evidence in support of abstract Victorian taxonomies, or ecological ideas, and also of active engagement with the natural world through personal witness.

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[109] Tucker 2005: 12
[110] Sontag 1977: 4

7. Conclusion

An article of equipment that is more or less indispensable is a good photographic camera. A photograph supplies one of the best means of fixing facts in one's mind as well as presenting them to others.[1]

Those who head to the field have their own understanding of its location and character.[2]

Part history of science and photography, part historical epistemology, part ethnography of science practice and scientific subjectivities, the driving question behind the study has been to understand how specifically ecological knowledge-claims came to be understood and accepted, and how they were configured in relation to common experience and to the broader social practices of science. The study of photography within science is an exemplary tool for such an inquiry because photography is ubiquitous and ordinary. These are also the characteristics that have rendered its practices invisible and its agency obscure. Photography's invisibility was so complete by the beginning of the 20th century that it had become a commonplace tool, adopted uncritically by most scientists, its representational powers taken for granted. Even language does not escape attention so thoroughly as photography, and it is this very invisibility, its unexamined but widespread application, that marks it out as a valuable tool for investigating knowledge practices in the places and disciplines where it is put to work.

In this thesis, that investigation has required a broad combination of tools and analytical categories, most of which have not previously been applied to ecology's early history, and certainly not to ecological photography. My analytical toolkit has borrowed from the history of science, particularly those methods that stress the importance of practice and of the places where science takes place, but the study is also inflected by considerations of historical epistemology and their expression in the *visual* culture of ecology. Taking seriously the necessity for a close study of scientific practices has entailed an ethnographic approach, to bring out the detailed social and discursive complexion of photographic practice in ecology, in society meetings, in the field and in print publication. The visual quality of ecological work and discourse, and ecologists' marked reliance upon photographic methods, has taken the investigation into the realm of visual and material culture studies, tracing the practical

[1] Bews 1926: 266
[2] Canfield 2011: 5

contexts of photographs as objects of representation and knowledge exchange. Finding this approach insufficient to the task of explaining the visual practices of ecology in the field I have, finally, extended the analysis of visual and material culture to encompass an experiential approach to the ethnography of field practice in ecology and related natural history studies.

All of this amounts to a certain kind of history for photography; one that is less about the ontology of photographic images, or the nature of visual or scientific representation, than it is about the effects of photographic practice and photographic objects when applied to ends other than photography. For ecologists, and doubtless for other scientists, the detailed practices of image making and image use, the exchange and circulation of material and visual artefacts, were expected to produce and communicate knowledge. This thesis, consequently, interrogates the work images and image-making were asked to perform in disseminating and regulating ecological knowledge, their use as rhetorical tools for disciplinary formation, as methodological 'tools of observation', and as tokens of experience and embodied cognition.

Ecological vision

Photography, and its products, were ubiquitous in the first decades of self-conscious scientific ecology, and almost entirely untheorised by its ecological practitioners. When ecologists mentioned their photographic practice at all, the slender theoretical grounding they offered presented photography as the unproblematic adjunct of common sense.[3] Such an uncritical stance with regard to photography and its apparent representational realism was common enough by the end of the 19th century and has often obscured photography's constitutive role in cultural action and knowledge formation. By this time, commercial markets in photographic technologies were well developed, cameras and photographs were commonplace appurtenances to ordinary domestic and leisure experience. They were equally insinuated into any number of utilitarian endeavours and a wide range of scientific practices. To this extent, it is unsurprising that a new science, attempting to establish itself in the conservative disciplinary framework of late 19th century botany, should embrace

[3] Others have attested that photography's hold on popular and scientific imagination has been largely obscured by the sheer ubiquity of photographic images (Edwards 2001: 34; Schwartz and Ryan 2003: 7; Tucker 2005: 9). Abigail Solomon-Godeau observed over twenty years ago that photography is 'a medium whose very ubiquity may well have fostered its invisibility as an object of study' (Solomon-Godeau 1991: xxi).

photography as a ready technology of representation and rhetoric, seeking to persuade others of the merits and insights of a new outlook on botanical science.

However, the new outlook proposed by ecologists was not simply a matter of innovation in scientific illustration. Rather, it constituted a profound challenge to the visual and empirical foundations of established botany. It required botanists to return to the field to look again at plants as they grew in their natural settings, rather than in the laboratory which had come to dominate late 19th century biology in all its guises. In a significant epistemological break with botany's taxonomic and morphological traditions, ecologists learned to *see* vegetation differently. They turned away from taxonomic and floristic conceptions of plant-life focused on taxonomic categories (principally the *species*), to recognise vegetation as a range of complex associations between plants and their environment. This new way of seeing *required* a descriptive mode which paid considerable attention to visual experience and to visual methods for presenting that experience to others. Together with other visual methods, photography's presumed fidelity to visual experience made it a persuasive rhetorical tool, providing descriptive evidence for the concept of the plant community, but also a compelling expression of the visual basis for ecological knowledge obtained in the field by examining particular instances of vegetation.

In fact, the ecological outlook was not entirely new. Its theoretical construction of vegetation as plant 'formations' or 'associations' had been proposed early in the 19th century by Alexander von Humboldt, and further developed by a number of succeeding phytogeographers (geographical botanists). As chapter 2 of this thesis demonstrated, the work of these early students of vegetation also revealed the profoundly visual basis for ecological understanding. Humboldt's tableau from Mt. Chimborazo (Fig. 2.1) was conceived as part of a 'general physics of the earth' but it was also a complex visual argument, (re)presenting Humboldt's visual and aesthetic encounter with the Ecuadorian landscape and its vegetation. Anton Kerner and Andreas Schimper shared Humboldt's central commitment to skilled vision as the basis for scientific judgment but neither was able to achieve a representational strategy adequate to the task of differentiating ecological vision from the old botanical epistemology founded on morphology and the taxonomic unit of the species. Even when Schimper made photographic illustration the standard for such work, he failed to overcome the stylistic and epistemological constraints of conventional botanical illustration and explorer botany. The ambivalent recoding of images imported by Schimper from other contexts reveals the general limitations imposed on photographic meaning by deeply entrenched epistemological assumptions, especially when those assumptions have already been inscribed into conventions of pictorial representation. Chapter 2 described these visual strategies for representing vegetation and underlined the visual basis for a shift from species-based, floristic phytogeography, to an ecological vegetation science in which tacit visual methods became critical to the subsequent development of the new science.

Robert Smith and Charles Flahault's excursions (see Introduction, 'At a glance'), and their successors in vegetation survey work, confirmed the visual recognition of plant associations as a central concern in ecology's new scientific enterprise. Ecological botanists dedicated their fieldwork not to finding and collecting plants but to recognising and describing such plant communities. These, the first self-conscious ecologists, wanted to bind the description of vegetation much more tightly to what they could see during field survey. For this, detailed mapping and photography became standard techniques for observation, and as methods for representing the visual knowledge acquired during fieldwork. Unlike other botanists, however, ecologists could not return from the field with specimens. Photography provided a means to bring home 'plant associations' for shared observation and discussion, and as surrogates for the direct experiences of field encounter. Photography itself, we should remind ourselves, was a mode of collecting "direct from nature".[4] The camera became an essential component of ecological field instrumentation, as a technology of scientific observation and record, and as a means to represent that evidence to a broad community of botanists and other field scientists.

Photography answered to the ecologist's desire for descriptive detail, to deepen and strengthen the evidential and rhetorical force of ecological observation. The photograph takes and gives up all this detail, like Flahault's eye, 'at a glance', as if the viewer were present before the view.[5] In other contexts, such details present a problem of excess, of accidental inclusion that distracts and confuses a photograph's intended meaning.[6] For the vegetation

[4] Armstrong 1998: 32; The notion of photography as a collecting practice is explicit also in Schwartz 2006; Tucker 2005: 26-7, and Mitman and Wilder 2016 (in press).

[5] See Daston 2008 for a longer discussion of the notion of perceiving complex scientific phenomena 'at a glance'. The ability to capture the complex organisation and character of vegetation 'at a glance' crops up repeatedly in early ecologists' accounts of their own and each other's work. Whilst this kind of observation appears to the uninitiated as a matter of intuition, it is actually achieved through long experience and repeated observation. It is, consequently, an essential component of what Lorraine Daston and Peter Galison describe as 'trained judgement' (Daston and Galison 2007: 309-362).

[6] The 'random inclusivity' of photographs, to use Elizabeth Edwards' phrase (Edwards 2008: 333) was a particular source of anxiety for anthropologists, as well as for many photographers. See also Poole 2005; Edwards 2012a: 75. Such accidental inclusions are also the source of what Roland Barthes called the 'punctum', the unlooked-for detail in a photograph that pricks an unintended response and

ecologist, this kind of visual record provided a descriptive power that could not be replicated in verbal terms, presenting detailed accounts of the character and constitution of particular stands of vegetation. Moreover, photographic excess made sense of ecological excess. It conveyed a sense of complexity that was essential to the ecological notion of the plant association itself. Even as it yielded all the complex visual detail of vegetation, its physiognomy and species composition, the wider view of vegetation simultaneously deflected attention from individual organisms, individual species. Photography allowed ecologists to 'step back' to take the view, to fix the complex association of plants as the object of attention and study and, in the process, created a new epistemic object for botanical science.

Material and social practice

The rhetorical weight of such descriptive photographs relied on their visual complexity, together with a conviction in the optical realism of photography. Photographs were records of actual observations and were expected, through 'virtual witness',[7] to engender conviction in the reality of plant communities and the qualities of their sensory encounter. As we saw in chapter 3, in the first decades of the 20th century, Britain's first ecologists devoted considerable energy to mobilising this kind of virtual witnessing. They displayed a lively engagement with the civic apparatus of science, as active members of natural history societies, and as effective contributors to the cultures of knowledge exchange, through presentations and discussions at society meetings and conferences in local, national and international contexts. As field practitioners, they inevitably found much common ground with naturalists, and integrated closely with their customary excursion-practices for field botanising and other natural history pursuits. Within a decade or so, the new ecologists had also begun to develop their own institutional framework at local, national and international levels, establishing the world's first ecological society and a new scientific journal for ecology.

In all these contexts, photography was central to the flow of ideas and the exchange of knowledge across these networks and in the development of a self-conscious community of ecological practice. Ecologists relied consistently on photography as a rhetorical strategy for recruiting others to their new science of vegetation and for 'working out' the fundamental concepts and methods of that should be applied to their study. They met together, in the field

disrupts its meaning (Barthes 1981: 26-7). Clive Scott (1999: 30) also discusses what he calls the 'non-motivated detail' of the photograph in this context. See also Kelsey , for an extended inquiry into the role of chance in photography, including the problems and potential of incidental detail.

[7] Shapin and Schaffer 1985: 60-65; Tucker (2005).

and in society meetings, sharing field experience and visual knowledge over photographs, exchanging prints and lantern displays, alongside other natural objects and visual artefacts, to describe and understand what they saw in plant associations. They also published intensively, both in existing journals and in new publications of their own, generating a new visual approach to the presentation of field survey data which relied heavily on photographic views of vegetation. In the resulting exchange and flow of visual argument, they mobilised photographs and maps in particular, as descriptive tools and 'picture proxies' for the visual knowledge acquired during fieldwork.[8] The visual grain of ecological fieldwork, the importance of the field as a geographical and social space for making ecological knowledge, and the comprehensive constitutive role of photography in ecological practice, are all succinctly summarised in a photograph by Elizabeth Cowles (see Frontispiece), from the International Phytogeographical Excursion (IPE) in 1911, which describes the details of vegetation and simultaneously records another ecologist, the Belgian Jean Massart, at work with a stereographic camera, with which he too recorded numerous details of vegetation and the social progress of his fellow travellers.

For many botanists however, vegetation was too confused and too confusing to be an object of study in itself. They were sceptical about plant communities and continued to focus their attention on the individual plant species that they believed were already given to sight. The resulting uncertainty is evident in the progress and character of ecological photography in which many botanists, even when they were convinced of the reality of plant associations, produced visually ambivalent photographs which failed to relinquish their primary concern for plant species over community.[9] In the first decade of the 20th century, ecologists were sharply conscious that their science and their understanding was in its infancy.[10] Very little of what they thought they knew could really count as settled knowledge and future research would certainly bring new insights and a reorganisation of previous ideas. The photograph's assumed transparent record was of value, therefore, not only for settling current questions of the reality or character of plant associations; it was important as a record for settling future

[8] On 'picture proxies', see Rudwick 2005: 75-76.

[9] This ambivalence is also discernible Elizabeth Cowles' IPE photograph of Massart (Frontispiece), in which the details of vegetation are apparent but the image foregrounds the *Arbutus* or strawberry tree of the photographer's caption. The extent of the photographer's ambivalence is fully apparent in the wider context of the IPE, for which participants were provided with detailed descriptions of the plant communities they could expect to encounter during their excursion, which specifically contextualised *Arbutus* within a particular type of woodland association, the *Quercetum sessiliflorae* (Tansley *et al* 1911a: 138-140).

[10] Tansley 1904a; Clements 1905: 6; Warming 1909: vi.

controversies. Moreover, vegetation was dynamic and plant associations were subject to change, through succession or disturbance. Current visual records could not, therefore, always guarantee future observations. For both these reasons, early ecologists also shared a widespread conviction in the value of a photographic archive for the benefit of current and future science. Collections of ecological photographs would provide a compelling weight of evidence and description for plant communities as an object of study. Consequently, in Britain, ecologists began to collect what they thought were suitable photographs for these purposes, in both institutional contexts and as private individuals. The development and fate of the resulting collections of ecological and botanical photographs is instructive, however, not only as a manifestation of this conviction in the value of the photographic record and its archive, but also because it made apparent a continuing epistemological confusion between floristic botany and ecological vegetation science.

Rhetoric and representation

The visual and epistemological confusion between floristic botany and ecological vegetation study was especially evident in the developing print culture of ecology. Through an analysis of the detailed content of this visual argument in the context of print publication, chapter 4 of this thesis illuminated more fully the character and extent of visual practice in ecology in the early 20th century. However, it also laid open this persistent ambivalence in relation to the primary objects of ecological study. A vibrant print culture was critical to the establishment and credibility of ecology as an emerging science at the start of the 20th century. In Britain, ecologists co-opted botanical publications and developed new journals to promote their science. They produced textbooks on methods and monographs on the vegetation of particular regions and for the British Isles as a whole. In all these cases, they deployed photographs intensively, both as scientific *evidence* for ecology, and as evidence of the *practice* of scientific ecology. Photography was as central to the rhetorical presentation of ecology and its objects in print as it was in society meeting rooms and lecture halls.

Ecologists' commitment to photography in print also set them apart, visually and rhetorically, from other kinds of botanical science. Despite photography's ubiquitous hold on both scientific and popular imaginations by 1900, botanists made very little use of photography, especially in publication. Some naturalists and botanists used cameras, and photographically illustrated, popular publications were numerous enough, but the uses of photography in scientific botany were largely confined to photo-microscopy, to occasional specimen-photographs and to informal photographic records made during field-excursions. For ecologists, however, from the late 1890s photography quickly became central to their methods, both for ecological investigation and its subsequent representation.

Nevertheless, plant associations continued to be a source of confusion for many taxonomically inclined botanists and, even for some ecologists, remained an uncertain and wavering object of attention. This ambivalence, especially manifest in a continental European context, was often present in the descriptive texts accompanying photographic representations of vegetation (see chapter 4, *Die Vegetation der Erde* et seq). It was especially evident in the pictures, however, and this demonstrates an important function for visual and photographic history, its capacity to make explicit the nuanced ambiguities of scientific understanding in a particular period or field. In such contexts the appearance and use of photographs can be read *against* their context, as well as with it, to reveal tacit assumptions and areas of uncertain or contested knowledge. In this case, reading against context foregrounds both the problematic nature of photographic evidence and representation for botany, and the fundamental epistemological divisions at stake in the emergence of ecological thinking.

Visual tools

Most accounts of visual science assume that the implicit purpose of visual method is representation. This is certainly the case for many, perhaps most, forms of scientific visualisation, in which the imperceptible and the abstract are objectified as visual artefacts.[11] Photographs, as objects of representation and communication, as we saw in chapters 3 and 4, certainly played a central role in early ecological practice in general. My account of the visual field practices of ecology suggests, however, that visual methods are sometimes just that, methods to refine or extend direct visual observation and the knowledge to which such observation permits access. This kind of visual knowledge, equated with the fallibility of the observing subject, has been more-or-less systematically erased from science's accounts of its own practice, including ecology, in favour of instrumental accounts of method and 'objective', quantitative forms of data collection and reporting.

In chapter 5, I argued for ways of understanding photographic practice beyond matters of representation. The argument was worked out with reference to ecological survey practice, concentrating on the visual and bodily engagements of ecologists with the objects of field

[11] For numerous examples, see Lynch and Woolgar 1990; Coopmans *et al* 2014; Hentschel 2014.

study, and their registration in mapping and photography. For ecologists, photographs were objects of study in themselves, whose scrutiny could yield new knowledge when the primary object of inquiry was no longer present. Ecologists used photographs (and maps) in the field, as working tools, as well as in communications with others. Field photographs were not simply representations, they were records which could be redeployed in the field as scientific tools in their own right. The camera was a technology for looking as well as representing, and an instrument for generating new tools of observation — that is, photographs. For ecologists engaged in field survey, maps and cameras were instruments of active observation. With the simplest of tools (pencil and paper), ecologists sketched plant associations onto Ordnance Survey maps, reinscribing the products of rational cartography with the evidence of their own sight. In the same way, they used cameras and photographs, not solely for producing pictures of rhetorical and evidential value, but as cognitive extensions for the visual, embodied experience of field observation. To be clear, I do not mean here the prosthetic extension of vision by which 'scientific photography' opens perception onto the invisible, the genre of extraordinary views to which I alluded in my introduction. I mean the use of photography as a technology for recording and preserving the contents of ordinary visual experience.

This subjective, visual experience of field survey, and its photographic instrumentation, also underpinned the quantitative techniques developed by ecologists for studying vegetation in the field. Even as they sought to standardise methods and to present their developing science as objective and quantitative, their most effective methodological and instrumental innovations relied on visual acuity and judgement, allied to specialist botanical knowledge and environmental measurement. The botanical quadrat, one of early ecology's most influential and lasting methodological innovations, provided a model case for this reliance upon skilled vision. In the quadrat method, ecologists found a technique for precise mapping and botanical quantification which was reliant, nevertheless, upon subjective visual estimation. The resulting combinations of graphical record and data included both photographic and hand-drawn visual objects. These tools of observation, far from producing a robust mathematical science, confirmed the importance of subjective judgement and skilled vision as the foundations for ecological knowledge. In this context, the technologies of scientific vision — drawing, photography, cartography — should be seen not as distancing regimes of standardisation by which to rein in the subjectivity of the eye. Rather, they were prosthetic extensions for transforming and communicating ordinary visual experience. Ecologists sketched and photographed more consistently and more comprehensively than they measured and counted. These visual practices, the working tools of observation and evidence, were critical to the development of personal ecological knowledge, to the recognition of the objects of ecological study, and to the development of a collective empiricism for ecology as a new discipline.

Such cognitive applications of cartography and photography in ecology, and the embodied cognition entailed in these field encounters, require us to think beyond representation and rhetoric, and to adopt a broader conception of scientific practice that goes beyond either its conceptual content or its social articulation. As Karin Knorr Cetina has pointed out, standard conceptions of 'practice' are limited by their emphasis on habitual and rule-governed features.[12] Falling in with Bourdieu's refusal of the phenomenological aspects of practice, this social orientation stresses regulation and procedural conformity, at the expense of responsive adaptation and flexibility in individual rule-following or knowledge construction.[13] In practice, as Knorr Cetina says, "knowledge-centered work shifts back and forth between the performance of 'packaged' routine procedures and differentiated practice".[14] The fixation of knowledge requires settled objects and routine procedures, but knowledge construction also requires differentiation and innovation in response to non-standard contexts. The images that derived from ecological field practice, and their wider mobilisation across communities of knowledge, answered to requirements for the 'fixation' and circulation of scientific knowledge[15]. But they also articulate the responsive subjectivity provoked by the embodied encounters of working scientists. Ecologists sought to make sense of vegetation through innumerable individual and shared acts of visual cognition, obtained and practiced in the field, using pencils and maps, cameras and photographs, as tools for observation. Photographic displays functioned as rhetorical tools for the socially coherent formation of ecological knowledge; but photographic practice in the field functioned to structure scientific knowledge at the level of individual encounter, inflecting and shaping the *habitus* of intersubjective experience, in a community of similarly scientifically minded observers.

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[12] Knorr-Cetina 2001.
[13] Bourdieu 1977: 4. See Taylor 1993 for a valuable discussion of Bourdieu's rule-following and its relationship to Wittgenstein's thinking on the same matter.
[14] Knorr-Cetina 2001: 196
[15] Amann and Knorr-Cettina 1988.

Ecology in place

If ecological habitus and knowledge are, as I suggest, structured and articulated through subjective action, as well as through settled convention and procedure, then a full account of ecological knowledge must pay heed to definite practices, from the perspective of the scientific practitioner, as an observing body, making sense of the world through sense as well as through representation. Chapter 5 of this thesis provides just such an account for the detailed, embodied practices of ecology and underlines once again the visual foundation for ecological experience and knowledge, and the central role of photographic practice as a kind of extended visual cognition.[16] This approach has the merit of forcing close attention not only to the detailed cognitive techniques of ecology, but to the specific places of scientific action. As Thomas Gieryn says, all scientific knowledge-claims "originate at some place."[17] For ecologists, natural knowledge — their understanding of vegetation, and of their own scientific practice — was tied uniquely to the field, and to particular geographical locations where their objects of study, plant communities, could be found.

A further merit of the approach from embodied practice is that it allows our inquiry to encompass what Knorr Cetina calls the "affective and relational undergirding of practice."[18] What Knorr Cetina means here by 'relational' is the subject-object relations which structure scientific procedure and performance. The objects of science are not always material things, but they frequently include any number of material objects, from plants and animals to specimens and soils, microscopes to MRI scanners, photographic emulsions to printed pictures, and to stands of vegetation and the physical places they occur. It was through their attachment to the field, to the places and objects of their science — first plant-life and then the animals to which vegetation provided a habitat — that ecologists made sense of the image-objects (photographs) they shared and circulated through practices of exchange and display — whether hand-to-hand, in public performance or in print (see chapters 3 and 4 for instances of all these). Ecologists understood the complexity of the natural world by their

[16] The notion of 'extended cognition' is a contentious one in cognitive science and philosophy and is often proposed in conjunction with closely related concepts of 'embodied cognition' and 'extended mind'. Whilst I have argued strongly in this thesis for a role for embodied cognition in ecological practice, the instrumental extension of sensory cognition does not necessarily equate with an argument for extended mind. For fuller explanations of these related concepts, see Wilson 2002; Clark 2008; Rowlands 2010; Shapiro 2015. Malafouris (2013) has applied these concepts to the relationship between cognition and material culture. Hutchins (1995) has described extended cognition also to encompass social relations, in what he calls social 'socially distributed cognition'. For a contrary discussion of extended cognition, see Rupert 2004.

[17] Gieryn 2002: 113.

[18] Knorr-Cetina 2001: 184.

direct experience of being 'in the field'. The ubiquity of photography in ecological practice attests not, primarily, to a desire for representation or mechanical objectivity — though ecologists did trade on the photographic aura of authenticity, accuracy and reliability. Rather, photography, and its field-uses in particular, provided the means to anchor scientific practice in subjective experience and, conversely, to anchor subjective experience in science, to set the authenticity of personal witness and presence as the ground for insight, description and interpretation. Even as they strove to meet the demands of 'hard science' — precision, simplification, accuracy, repeatability, objectivity — by measuring, counting and experimenting, ecologists knew their science was based in large part on subjective experience and judgement, derived from personal sensory engagement with the natural world.

This affective and relational practice is also what ties ecology to other forms of field natural history. As we saw in chapter 6, the social and material practices of field study, of collecting and exchange, reveal linkages between objects, photographs and knowledge across a much wider realm of natural history study. Photographic practice and exchange came to fulfil an equivalent role to established material practices in the performance and structuring of knowledge in ecology and natural history more generally. The photographic performance of scientific observation in the field resembled the collecting practices of naturalists; views of vegetation, or photographs of birds in their natural setting, were records of visual encounter, observations to be collected, exchanged and displayed. When ecologists shared a photographic view of vegetation, in addition to whatever information or representational content it might convey, the material object of the photograph functioned like any other specimen passed between naturalists. Both specimens and photographs were tokens of objective knowledge *and* subjective experience, revealing an affective aspect to the practices of natural history, tied to the particular places of field-study. In the field or in society meetings, such photographs provided not only visual evidence, but also records of sensory engagement with an affective natural world. In these contexts, ecological photographs took their place alongside natural specimens and other tokens of experience, as personally and socially salient objects that draw meaning and agency from the relationship between their material existence and their function as objects of exchange and display.

When re-inserted into this wider domain of natural history practice, the experience of field ecology, both as science and as sensory practice, made photography a natural ally — both as a tool for scientific observation and as a cognitive and sensory extension of the body of the field naturalist. Photography answered to the field ecologist's requirement for specificity; in forging new scientific objects, it was necessary to show real examples in real places. But the material objects of scientific natural history — photographs, specimens — tie together the habitus of scientific field practice with its social and institutional articulation, through an affective attachment to places and things. By broadening the focus from ecological practice to wider natural history in this way, the role of photography in structuring and communicating the embodied, cognitive work of field study is made more apparent, and the habitus of ecological practice is also brought closer to that of everyday experience.

Photography, history, theory

This thesis demonstrates the value of photographic history as a tool for interrogating disciplinary discourse and practice. It substantiates the value of archive-led research and indicates particularly the importance of small and little-known archival sources, including photographic materials within archives that are primarily non-photographic, for a study in photographic and visual practices. It demonstrates especially the historically fruitful combination of visual and other documentary resources, reading photographs in combination with other archival sources such as notebooks, diaries and correspondence and, most importantly, against primary published texts in which archival images were reproduced. The thesis also extends visual science studies into a new area, investigating the operations of photographic practice in a particular scientific context. It traces the circulation of photographs through different institutional and discursive contexts and demonstrates in detail the role of photographic discourse in mediating scientific knowledge and disciplinary aspirations. As a direct contribution to the history of science, the thesis casts light on important epistemological distinctions that were central to the early development of scientific ecology. Through its detailed emphasis on practices, especially the field practices of ecology and related natural history studies, the thesis also extends the sociological and ethnographic insights of the history of science and science and technology studies. Through a detailed examination of visual science and photographic practice in ecology, the thesis acknowledges the agency at work in material culture and its associated social practices, whilst also seeking to understand the idiomatic and subjective aspects of practice, even when it is proposed as a vehicle for rational knowledge.

The resulting study of photographic practice in ecology has confirmed the intensely visual character of ecological investigation, knowledge and communication, at least in its early decades from the start of the 20th century. It has also revealed the significant epistemological ambivalence in efforts to establish ecological vision as a distinctive branch of botanical science. This distinctively photographic articulation of uncertainty, amongst early 20th century botanists with regard to plant associations, suggests a role for photographic history in understanding the epistemological foundations for competing knowledge claims that might otherwise appear as methodological or disciplinary differences. Photographic projects like Czech botanist Hugo Iltis's *Flora Photographica* are significant in this respect. They indicate the rhetorical capacities of photography within a particular disciplinary discourse, but also its limitations when epistemological preconceptions intervene to constrain both the character of the images and the possibilities for reading or interpretation.

Historically, the differences between ecologists and other botanists at the start of the 20th century were in fact played out largely in those disciplinary and methodological terms, suggesting that any underlying epistemological distinctions were as obscure to many contemporary practitioners as to their subsequent historians. Nevertheless, photography was prominent here too, in ecologists' efforts to establish and consolidate their new community of interest and knowledge. Ecologists were particularly devoted to photographic methods for rhetorical display, especially when compared with their botanical colleagues, and especially in publication. In general, however, their social and material practices for circulating knowledge and for establishing disciplinary authority reflected those of their contemporaries in both amateur and professional science. Just like other biologists, physicists, anthropologists and geographers, ecologists attended and spoke at conferences, society meetings and soirées, featuring displays of natural objects, photographs and other visual artefacts. This is a pattern that confirms other studies in the civic cultures of Victorian and Edwardian and in the entwined practices of science and photography.[19] This thesis extends such studies, however, by providing a detailed portrait of photographic practice, scientific discourse and knowledge circulation in a particular disciplinary context.

Important as these social and disciplinary patterns of practice are, however, this thesis also offers additional resources for thinking about scientific and photographic practices, and their relationship to ecological knowledge. For early ecologists, natural knowledge was bound to their sensory and embodied engagement with the objects and places of their study. The detailed visual and material practices of field ecology, and other kinds of natural history, provided us with tools for understanding the operations of knowledge formation at the level

[19] For examples of this civic infrastructure in Victorian and Edwardian natural history, see Allen 1976; Alberti 2000; Finnegan 2009; and Naylor 2010.

of individual subject-object relations. As ecologists engaged with their objects of study, deploying a range of techniques for rationalising observation, collecting specimens, making photographs and other visual artefacts, they were not visualising knowledge but making sense of knowledge that was already visual. The instrumental practices of fieldwork — in particular photography and mapping — functioned as cognitive extensions for observing and making sense of the natural world, and for articulating the affective and cognitive disposition of the observing scientist. Literally, and figuratively, maps and photographs helped ecologists to understand what they could see when they looked at vegetation and where they stood in relation to what they saw. Photographic images and other visual artefacts provided proxies for direct observation and surrogates for sensory experience in the field. Photographs, as material objects, circulated and accumulated, like other natural history specimens, as tokens of knowledge obtained and brought back from the field. The result of this ethnographic and experiential investigation of field practice is a finely-textured account of ecological *habitus*, together with its generative mechanisms, operating within an extended 'meshwork' of social, technical, cultural, scientific and subjective life.[20]

[20] On 'meshworks' see Ingold 2011: 63-94.

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